Operator Manual

ORBISPHERE 3654

HACH ULTRA™

EXCELLENCE IN PROCESS ANALYTICS

Revision H - 14/03/2008

Product Recycling Information

ENGLISH

Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of-life equipment to the manufacturer for disposal at no charge to the user.

Note: *For return for recycling, please contact the equipment manufacturer or supplier for instructions on how to return end-of-life equipment for proper disposal.*

DEUTSCH

Elektrogeräte, die mit diesem Symbol gekennzeichnet sind, dürfen in Europa nach dem 12. August 2005 nicht mehr über die öffentliche Abfallentsorgung entsorgt werden. In Übereinstimmung mit lokalen und nationalen europäischen Bestimmungen (EU-Richtlinie 2002/96/EC), müssen Benutzer von Elektrogeräten in Europa ab diesem Zeitpunkt alte bzw. zu verschrottende Geräte zur Entsorgung kostenfrei an den Hersteller zurückgeben.

Hinweis: *Bitte wenden Sie sich an den Hersteller bzw. an den Händler, von dem Sie das Gerät bezogen haben, um Informationen zur Rückgabe des Altgeräts zur ordnungsgemäßen Entsorgung zu erhalten.*

FRANCAIS

A partir du 12 août 2005, il est interdit de mettre au rebut le matériel électrique marqué de ce symbole par les voies habituelles de déchetterie publique. Conformément à la réglementation européenne (directive UE 2002/96/EC), les utilisateurs de matériel électrique en Europe doivent désormais retourner le matériel usé ou périmé au fabricant pour élimination, sans frais pour l'utilisateur.

Remarque: *Veuillez vous adresser au fabricant ou au fournisseur du matériel pour les instructions de retour du matériel usé ou périmé aux fins d'élimination conforme.*

ITALIANO

Le apparecchiature elettriche con apposto questo simbolo non possono essere smaltite nelle discariche pubbliche europee successivamente al 12 agosto 2005. In conformità alle normative europee locali e nazionali (Direttiva UE 2002/96/EC), gli utilizzatori europei di apparecchiature elettriche devono restituire al produttore le apparecchiature vecchie o a fine vita per lo smaltimento senza alcun costo a carico dell'utilizzatore.

Nota: *Per conoscere le modalità di restituzione delle apparecchiature a fine vita da riciclare, contattare il produttore o il fornitore dell'apparecchiatura per un corretto smaltimento.*

DANSK

Elektriske apparater, der er mærket med dette symbol, må ikke bortskaffes i europæiske offentlige affaldssystemer efter den 12. august 2005. I henhold til europæiske lokale og nationale regler (EU-direktiv 2002/96/EF) skal europæiske brugere af elektriske apparater nu returnere gamle eller udtjente apparater til producenten med henblik på bortskaffelse uden omkostninger for brugeren.

Bemærk: *I forbindelse med returnering til genbrug skal du kontakte producenten eller leverandøren af apparatet for at få instruktioner om, hvordan udtjente apparater bortskaffes korrekt.*

SVENSKA

Elektronikutrustning som är märkt med denna symbol kanske inte kan lämnas in på europeiska offentliga sopstationer efter 2005-08-12. Enligt europeiska lokala och nationella föreskrifter (EU-direktiv 2002/96/EC) måste användare av elektronikutrustning i Europa nu återlämna gammal eller utrangerad utrustning till tillverkaren för kassering utan kostnad för användaren.

Obs! *Om du ska återlämna utrustning för återvinning ska du kontakta tillverkaren av utrustningen eller återförsäljaren för att få anvisningar om hur du återlämnar kasserad utrustning för att den ska bortskaffas på rätt sätt.*

ESPANOL

A partir del 12 de agosto de 2005, los equipos eléctricos que lleven este símbolo no deberán ser desechados en los puntos limpios europeos. De conformidad con las normativas europeas locales y nacionales (Directiva de la UE 2002/96/EC), a partir de esa fecha, los usuarios europeos de equipos eléctricos deberán devolver los equipos usados u obsoletos al fabricante de los mismos para su reciclado, sin coste alguno para el usuario.

Nota: *Sírvase ponerse en contacto con el fabricante o proveedor de los equipos para solicitar instrucciones sobre cómo devolver los equipos obsoletos para su correcto reciclado.*

NEDERLANDS

Elektrische apparatuur die is voorzien van dit symbool mag na 12 augustus 2005 niet meer worden afgevoerd naar Europese openbare afvalsystemen. Conform Europese lokale en nationale wetgegeving (EU-richtlijn 2002/96/EC) dienen gebruikers van elektrische apparaten voortaan hun oude of afgedankte apparatuur kosteloos voor recycling of vernietiging naar de producent terug te brengen.

Nota: *Als u apparatuur voor recycling terugbrengt, moet u contact opnemen met de producent of leverancier voor instructies voor het terugbrengen van de afgedankte apparatuur voor een juiste verwerking.*

POLSKI

Sprzęt elektryczny oznaczony takim symbolem nie może być likwidowany w europejskich systemach utylizacji po dniu 12 sierpnia 2005. Zgodnie z europejskimi, lokalnymi i państwowymi przepisami prawa (Dyrektywa Unii Europejskiej 2002/96/EC), użytkownicy sprzętu elektrycznego w Europie muszą obecie przekazywać Producentowi stary sprzęt lub sprzęt po okresie użytkowania do bezpłatnej utylizacji.

Uwaga: *Aby przekazać sprzęt do recyklingu, należy zwrócić się do producenta lub dostawcy sprzętu w celu uzyskania instrukcji dotyczących procedur przekazywania do utylizacji sprzętu po okresie użytkowania.*

PORTUGUES

Qualquer equipamento eléctrico que ostente este símbolo não poderá ser eliminado através dos sistemas públicos europeus de tratamento de resíduos sólidos a partir de 12 de Agosto de 2005. De acordo com as normas locais e europeias (Directiva Europeia 2002/96/EC), os utilizadores europeus de equipamentos eléctricos deverão agora devolver os seus equipamentos velhos ou em fim de vida ao produtor para o respectivo tratamento sem quaisquer custos para o utilizador.

Nota: *No que toca à devolução para reciclagem, por favor, contacte o produtor ou fornecedor do equipamento para instruções de devolução de equipamento em fim de vida para a sua correcta eliminação.*

Product Disposal

Note:
The following only applies to European customers.

Hach Ultra is committed to ensuring that the risk of any environmental damage or pollution caused by any of its products is minimized as far as possible. The European Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) that came into force on August 13 2005 aims to reduce the waste arising from electrical and electronic equipment; and improve the environmental performance of all those involved in the life cycle of electrical and electronic equipment.

In conformity with European local and national regulations (EU Directive 2002/96/EC stated above), electrical equipment marked with the above symbol may not be disposed of in European public disposal systems after 12 August 2005.

Hach Ultra will offer to take back (**free of charge to the customer**) any old, unserviceable or redundant analyzers and systems which carry the above symbol, and which were originally supplied by Hach Ultra. Hach Ultra will then be responsible for the disposal of this equipment.

In addition, Hach Ultra will offer to take back (**at cost to the customer**) any old, unserviceable or redundant analyzers and systems which do not carry the above symbol, but which were originally supplied by Hach Ultra. Hach Ultra will then be responsible for the disposal of this equipment.

Should you wish to arrange for the disposal of any piece of equipment originally supplied by Hach Ultra, please contact your supplier or our After Sales Service department in Geneva for instructions on how to return this equipment for proper disposal.

Restriction of Hazardous Substances

Note:
The following only applies to exports of the product into the People's Republic of China.

Marking 标记

Products contain toxic or hazardous substances or elements.
含有有毒或者危险物质及成分的产品。

Environment Protection Use Period Marking (years).
环保使用期限标记（年）

	Toxic or Hazardous Substances and Elements 有毒或者危险物质和成分					
Part Name 部件名称	**Lead (Pb)** 铅	**Mercury (Hg)** 汞	**Cadmium (Cd)** 镉	**Hexavalent Chromium (Cr VI)** 六价铬	**Polybrom Biphenyls (PBB)** 多溴联苯	**Polybrom Diphenyls (PBDE)** 多溴联苯醚
1184 Board	X					
1112 Analog Board	X					
Spacer	X					
External Connector	X					

O: Indicates that this toxic or hazardous substance contained in all homogeneous material for this part is below the limit requirement
表示所有此类部件的材料中所含有毒或危险物质低于限制要求

X: Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement
表示至少有一种此类部件材料中所含有毒或危险物质高于限制要求

Table of Contents

Manual Overview

About this Manual

The information in this manual has been carefully checked and is believed to be accurate. However, Hach Ultra assumes no responsibility for any inaccuracies that may be contained in this manual. In no event will Hach Ultra be liable for direct, indirect, special, incidental, or consequential damages resulting from any defect or omission in this manual, even if advised of the possibility of such damages. In the interest of continued product development, Hach Ultra reserves the right to make improvements in this manual and the products it describes at any time, without notice or obligation.

Published in Europe.

Revision History

- Initial Release, November 1998, Orbisphere
- Revision A, April 2000, Orbisphere
- Revision B, July 2001, Orbisphere
- Revision C, July 2002, Orbisphere
- Revision D, October 2003, Hach Ultra Analytics
- Revision E, May 2004, Hach Ultra Analytics
- Revision F, February 2006, Hach Ultra
- Revision G, May 2007, Hach Ultra
- Revision H, July 2007, Hach Ultra

Safety Conventions

WARNING

A warning is used to indicate a condition which, if not met, could cause serious personal injury and/or death. Do not move beyond a warning until all conditions have been met.

CAUTION:

A caution is used to indicate a condition which, if not met, could cause minor or moderate personal injury and/or damage to the equipment. Do not move beyond a caution until all conditions have been met.

Note:

A note is used to indicate important information or instructions that should be considered before operating the equipment.

Safety Precautions

Please read the entire manual before unpacking, setting up, or operating this instrument.

Pay particular attention to all warning and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

Safety Recommendations

For safe operation, it is imperative that these service instructions be read before use and that the safety recommendations mentioned herein be scrupulously respected. If danger warnings are not heeded to, serious material or bodily injury could occur.

Service and Repairs

None of the instrument's components can be serviced by the user. Only personnel from Hach Ultra or its approved representative(s) is (are) authorized to attempt repairs to the system and only components formally approved by the manufacturer should be used. Any attempt at repairing the instrument in contravention of these principles could cause damage to the instrument and corporal injury to the person carrying out the repair. It renders the warranty null and void and could compromise the correct working of the instrument and the electrical integrity or the CE compliance of the instrument.

If you have any problems with installation, starting, or using the instrument please contact the company that sold it to you. If this is not possible, or if the results of this approach are not satisfactory, please contact the manufacturer's Customer Service.

Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and/or electrocution exists and indicates that only individuals qualified to work with hazardous voltages should open the enclosure or remove the barrier.
	This symbol, when noted on the product, indicates that the marked item can be hot and should not be touched without care.
	This symbol, when noted on the product, indicates the presence of devices sensitive to electrostatic discharge and indicates that care must be taken to prevent damage to them.
	This symbol, when noted on the product, identifies a risk of chemical harm and indicates that only individuals qualified and trained to work with chemicals should handle chemicals or perform maintenance on chemical delivery systems associated with the equipment.
	This symbol, if noted on the product, indicates the need for protective eye wear.
	This symbol, when noted on the product, identifies the location of the connection for protective earth (ground).
	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems. In conformity with European local and national regulations, European electrical equipment users must now return old or end-of-life equipment to the manufacturer for disposal at no charge to the user.
	Products marked with this symbol indicates that the product contains toxic or hazardous substances or elements. The number inside the symbol indicates the environmental protection use period in years.

Acknowledgements

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- Halar is a registered trademark of Ausimont U.S.A., Inc.
- Hastelloy is a registered trademark of Haynes International.
- Kynar is a registered trademark of The Pennwalt Corporation.
- Monel is a registered trademark of IMCO Alloys International, Inc.
- Saran is a registered trademark of Dow Chemical Co.
- Swagelok is a registered trademark of Swagelok Co.
- Microsoft and Windows are registered trademarks of Microsoft Corporation.

1 Installation

This section provides necessary information to set up the instrument. If you have any questions or experience any difficulties, do not hesitate to contact your Hach Ultra representative regarding this procedure.

1.1 What you have Received

The ORBISPHERE 3654 portable analyzer includes the following major components:

- An instrument, model 3654/xxx, with keypad, display, and handle.
- A membrane-covered thermal conductivity (TC) sensor, either model 3127x for H_2 measurement or model 31570 for N_2 measurement.
- A flow chamber, either model 32013A with flow adjustment valve for N_2 analyzers, or model 32015 without flow adjustment valve for H_2 analyzers.
- A WIN3654 program on a CD with a PC communications cable.

Also included with your shipment are two C-type batteries, a recharge kit in a plastic case containing materials to maintain your sensor and a model 32824A refilling hose to refill the purge gas cylinder

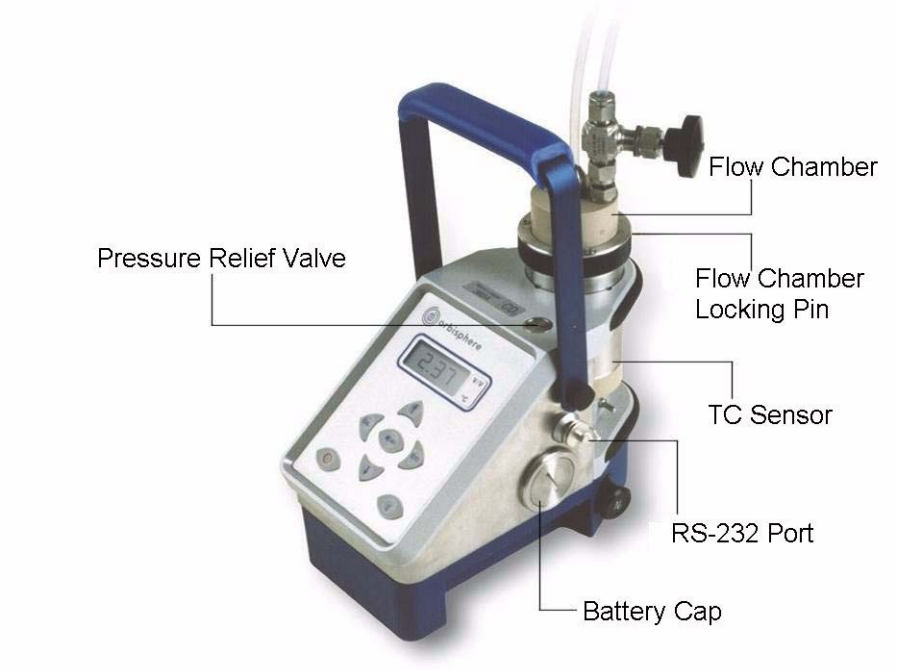


Fig 1-1: ORBISPHERE 3654 Portable Analyzer

Locate the instrument close to the sample being analyzed, and to the Personal Computer (PC) if one is being used. A LEMO-6 connector for RS-232 serial output to a PC is on the right side of the instrument (see Fig 1-1 above).

Make sure you install a fully charged set of batteries, or connect the instrument to an external power source (see “External Power Supply (optional)” on page 11), before switching the instrument on and exposing the sensor’s membrane to any liquid.

1.2 WIN3654 PC Program Installation

Install the WIN3654 program onto the PC by inserting the accompanying CD into your PC and running the SetUp program. Simply follow the on-screen instructions.

When finished, a new Windows Program Group labeled **Orbisphere** is created containing the software and help files.

1.3 Atmospheric Pressure Equilibrium

As soon as you receive the instrument, it will be necessary to ensure the interior and exterior of the instrument are both at the same atmospheric pressure. It is probable that during shipment these pressures will become different.

To ensure the pressures are equal, simply press the relief valve switch located on the top of the instrument (see Fig 1-1 on page 9) and hold it down for about 5 seconds before releasing.

1.4 Sensor Installation

The TC sensor connects to the instrument base through a 10-pin LEMO connector. A locking pin holds the sensor in place.

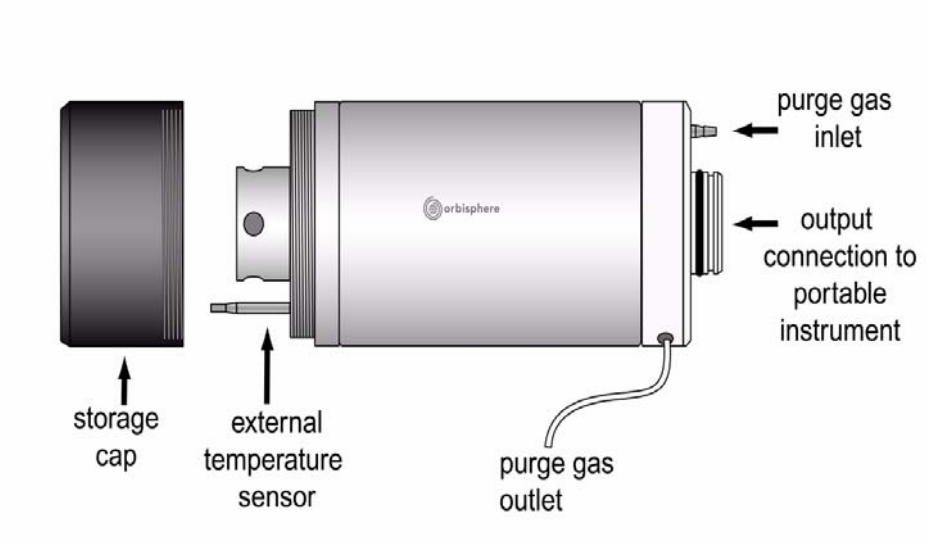


Fig 1-2: TC Sensor - Exploded View

Both the membrane-covered TC sensor and the flow chamber are shipped pre-installed on the instrument. It will, however, be necessary to remove the flow chamber when servicing the sensor. For details refer to “Sensor Maintenance” on page 43.

1.5 Purge Gas Connection

It is critical that the TC sensor has a supply of purge gas running before operating the system. The TC sensor, when exposed to a liquid sample, will become damaged if the purge gas is not running.

CO_2 is used to purge the N_2 sensor and N_2 or CO_2 is used to purge the H_2 sensor. A cylinder located at the bottom of the instrument supplies the purge gas. This cylinder is refillable (see “Purge Gas Cylinder Refill” on page 48).

The TC sensor is purged cyclically. In measurement mode, a cycle consists of a 4 second purge followed by 16 seconds of measurement. When the instrument is in standby, the purge time is the same, followed by a 17 minute delay. During the purge time, the flow rate varies, depending on the pressure inside the cylinder. At least four bubbles should exit from the purge gas exit during the purge time.

The purge gas input to the sensor uses a Tygon tube (4 mm outside/2 mm inside diameter, 110 mm long) that attaches to the base of the sensor. Refer to the exploded sensor diagram in Fig 1-2 on page 10.

The hole in the side and near the base of the sensor is the purge gas exit. To check the purge gas flow rate, push the supplied nylon tubing into this hole, to its limit. To disconnect it again, press on the ring surrounding the tube and pull out.

To check the purge gas flow rate, immerse the end of this tubing in water and switch on the instrument. Gas should flow intermittently out of the tube.

Note:
During normal operation, and especially when the instrument is in standby mode, ensure that the exit of the purge gas tube is exposed to the atmosphere and not in contact with any liquid or hard surface.

1.6 Connections

1.6.1 External Power Supply (optional)

The instrument is usually powered by the batteries supplied. You can, however, power it from an external power source using the model 32939 power supply adaptor as described and illustrated in “Model 32939 External Power Supply” on page 42.

Connect the male LEMO-6 plug on the 32939, to the RS-232 connector on the right side of the instrument. The female LEMO-6 plug can then be used to connect to your PC (if required) using the standard RS-232 cable supplied with the instrument.

Plug the transformer into your mains power supply using the cable supplied.

Note:
If the external power supply is not clean, this may result in unstable measurements.

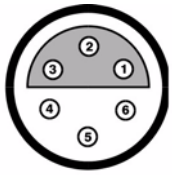
1.6.2 Instrument - PC Connection

An RS-232 cable is supplied with the instrument, with a 6-pin LEMO plug on one end and a 9-pin D-Type plug on the other.

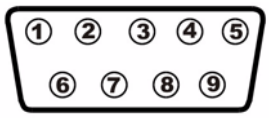
Note:
If you use an adapter for the connection to the PC, make sure it is designed for this purpose and, thus, has all nine pins accessible. Some 25-to-9 pin adapters are supplied for specific use, such as a mouse, and these may have only certain pins available.

It is not necessary to keep the PC connected to the instrument during measurement. This connection is required for downloading stored measurements, real-time monitoring, reviewing and changing configuration parameters and testing the instrument from the PC (see “Troubleshooting - Instrument” on page 50 for details).

Fig 1-3: Interface Box Connections



6-Pin LEMO Instrument Connector



9-Pin Male PC Connector

Pin	RS232 Signal
Pin 1	Transmitted data (TXD)
Pin 2	Received data (RXD)
Pin 3	Not Used
Pin 4	Not Used
Pin 5	Not Used
Pin 6	Ground

Pin	Use
Pin 1	Not Used
Pin 2	RS-232 Transmitted Data (TXD)
Pin 3	RS-232 Received Data (RXD)
Pin 4	Not Used
Pin 5	Ground
Pin 6	Not Used
Pin 7	Not Used
Pin 8	Not Used
Pin 9	Not Used

1.7 Flow Chamber Installation

The model 32013A or 32015 flow chamber allows the liquid or gaseous sample past the TC and temperature sensors. The flow chamber attaches to the TC sensor with a threaded collar and is sealed to the sensor with two O-rings (EPDM ∅20x2 mm and NBR ∅4x1.5 mm).

CAUTION:
At the top of the TC sensor is a thermistor to measure the sample temperature. Do not bend or damage this component.

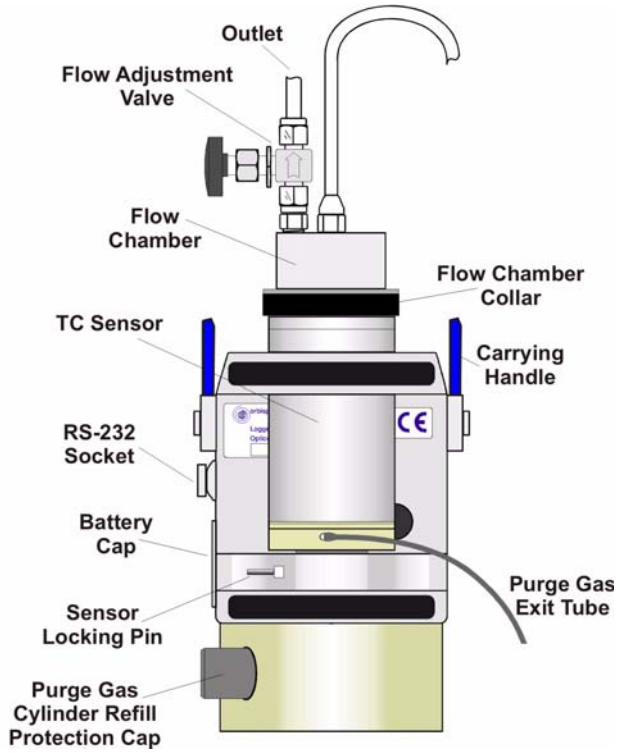


Fig 1-4: Flow Chamber 32013A

The flow chamber's inlet and outlet use ¼-inch diameter transparent plastic tubing. Connect by compression fittings to the sample source and to the drain, respectively.

You may also have received a model 32051 sample tube adapter to attach the flow chamber inlet tubing to the sampling point (see "WIN3654 PC Program Installation" on page 10).

1.8 Installation Completion Check List

1.8.1 Power

The instrument is designed to work on battery power or an external power supply.

If battery power should drop, a **[LO BAT]** warning appears in the instrument LCD's top left corner, and they should be replaced.

If using an external power supply, ensure that this is clean, otherwise it may result in unstable measurements.

1.8.2 Check the Purge Gas Supply

It is critical that the TC sensor has a supply of purge gas before operating the system. The TC sensor, when exposed to a liquid sample, could be damaged if the instrument purge gas cylinder is empty. At the same time, it is also critical that the instrument has a power supply to ensure the purge gas is supplied to the sensor on a regular basis. The system purges the sensor for 4 seconds every 20 seconds during normal measurement mode, and every 17 minutes during standby mode.

A small, pressurized cylinder at the bottom of the instrument supplies purge gas to the sensor. The purge gas required is:

- N_2 purge for H_2 measurements.
- CO_2 purge for N_2 or H_2 measurements.

Verify that the purge gas is flowing at more than four bubbles during the purge cycle, by placing the purge gas exit tubing into water.

Note:
You must supply power constantly to the instrument, since it purges the sensor continuously while power is on. When you put the instrument in standby, it still maintains the purge gas supply to the sensor. Thus, make certain to supply battery or optional external DC power constantly if the instrument is in standby and the sensor is exposed to a sample. The batteries will provide about three weeks of power for purging while the instrument is off.

1.8.3 Instrument Clock Setting

If you use the instrument to store measurements for downloading to a PC, you should verify the date and time settings of the instrument's internal clock, as described in “Clock Settings” on page 51.

1.8.4 Barometric Pressure Setting

The internal barometric pressure sensor has been factory calibrated but should be verified on-site with a precision certified barometer, and corrected if necessary. For instructions on how to do this, please refer to “Barometric Pressure Sensor Calibration” on page 35.

1.8.5 Sensor Membrane

Check that the membrane has been installed correctly, and is flat, tight, and wrinkle free.

1.8.6 Flow Chamber

The flow chamber inlet and outlet should be free of any obstructions. The model 32013A flow chamber, for dissolved N_2 measurements, has a flow adjustment valve on the outlet. The model 32015 flow chamber for H_2 measurements has no valve.

Dissolved Gas Measurements

Adjust the sample flow rate using the needle valve on the exit. When analyzing carbonated beverages, sufficient pressure must be provided to avoid degassing of the beverage during its passage through the flow chamber. Check for the absence of bubbles in the inlet tubing.

Gaseous Measurements

Place the outlet tubing in a container of water, ensuring that the flow chamber outlet is unobstructed (on the 32013A flow chamber, open the outlet valve completely). Then, adjust the inlet sample flow valve (main supply) to obtain one bubble per second at the outlet.

2 Operating Instructions

2.1 Operating Controls

The front panel of the instrument has a three-digit liquid crystal display (LCD). The LCD includes a right-side marker to distinguish between gas concentration and temperature display. This marker also indicates the measurement display units (g/kg, V/V, etc.) depending on the instrument configuration. To the LCD's right is a label showing the measurement units configured at the factory for your application.

Fig 2-1: Instrument Front Panel

In addition to the controls indicated on the front panel, there is also a pressure relief valve on top of the instrument (as indicated in Fig 1-1 on page 9). This button need only be pressed as part of the installation procedures, and/or if pressure builds up inside the instrument due to large temperature changes.

The panel keyboard has the following push-button controls:

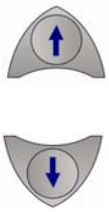
Power switch. Turns instrument power on or places in standby. When switched on, the instrument performs a series of start-up procedures before switching to measurement mode

Places the instrument in measurement mode

Calibrates the analyzer against a reference sample. This button can be locked out using the WIN3654 PC program

Stores a measurement value into memory

Backlights the LCD for approximately three minutes



Toggles between gas concentration and temperature measurement displays in measurement mode, increases or decreases the storage number during storage or memory view, or sets a calibration value during calibration

You can access other instrument functions by pushing one of the following keys while also pressing the power button:

Selects dissolved or gaseous measurement phase - see “Gas Measurement Phase” on page 29

Start automatic data acquisition - see “Automatic Data Acquisition” on page 20

Start memory storage view - see “Viewing Stored Measurements” on page 22

Starts continuous purge mode - see “Continuous Purge” on page 53

Display program identification information

Once you have completed the installation and start-up procedures defined in “Installation” on page 9, the analyzer can be operated independently, making measurements as a portable hydrogen or nitrogen gas analyzer.

You may store these measurement values for later analysis via the WIN3654 program (on your personal computer) or the memory view mode (on the instrument). The WIN3654 program operation is described in detail throughout the manual, where relevant.

2.2 Taking Measurements

To start the analyzer, press the **POWER** switch (located bottom left of the keyboard). When you turn power on, the instrument displays the software version number briefly, and then starts a series of start-up tests. This process should take only a few minutes, during which time a **[tSt]** message is displayed on the LCD. Once the tests are completed, a clearing message **[---]** is displayed for a further sixty seconds before the instrument switches automatically to measurement mode.

Note:
*The start-up tests will be repeated until successful, or for a maximum of 15 minutes. If the tests are still unsuccessful after 15 minutes, a **[Err]** message will be displayed and the instrument locked. Turn the instrument off and retry the start-up procedures, but if the problem persists, please contact your local Hach Ultra service representative for assistance.*

Measurement updates are displayed every 20 seconds, and it is normal for the right-most digits to vary in reaction to slight variations in gas content. For accurate measurements, the sensor's membrane must be at the same temperature as the sample to be analyzed. If this not the case, allow some sample to pass through the flow chamber for about 3 minutes before taking any measurements.

Minimum sample flow rates, measurement ranges and response times for the various membranes are given in the tables in “Sensor Specifications” on page 56.

The LCD includes a right-side marker to distinguish between gas concentration measurements and temperature. This marker also indicates the measurement display units (k/kg, V/V, etc. depending on the instrument configuration).

To switch between gas measurement and temperature measurement, press the **Up/ Down Arrow** buttons. To illuminate the LCD for approximately three minutes, press the **Backlight** button.

2.2.1 Select Gas Measurement Phase

Ensure the gas measurement phase is correct for this measurement. For details on viewing the current setting, refer to “Reviewing Instrument Configuration” on page 29. For details on changing this setting, refer to “Configuring the Instrument” on page 29.

2.2.2 Measurement Mode

You can set the measurement mode to normal or maximum. For details on how to do this refer to “Measurement Mode” on page 33.

Maximum mode facilitates making measurements in bottles and cans. To search for a maximum measurement value, press the **MEAS** button.

- The LCD first shows the message **[run]** for a few seconds, before displaying measurement values.
- After a 60 second measurement cycle, the instrument searches for two consecutive gas measurements with less than 2% difference. When this condition occurs, the displayed value freezes on the LCD (indicated by a blinking display), allowing you to note down or store the data.

The display remains frozen until you press the **MEAS** button to make a new measurement, or you select normal measurement mode (as described in “Measurement Mode” on page 33).

2.3 Storing Measurements In the Instrument

The analyzer will store up to 500 gas concentration and temperature measurement values, labeled by numbers 0 through 499, along with the current date and time of each measurement. You have the choice of acquiring this information manually or automatically, as described below.

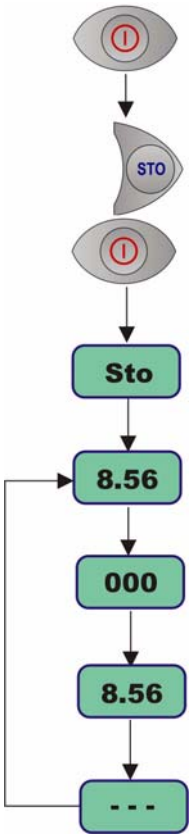
Note:
Do not put the instrument into standby while it is in the process of storing data, otherwise the data values will be lost.

Before storing measurements, you should verify the date and time settings of the instrument's internal clock, as described in "Clock Settings" on page 51.

2.3.1 Automatic Data Acquisition

Note:
*When the instrument is used to automatically store measurement data, all buttons except the **POWER** key are disabled. If enough time elapses to store all 500 values, the instrument will return to normal measurement mode and the buttons re-enabled.*

Before starting automatic measurement storage, first select the sampling rate desired using the WIN3654 program (see "Automatic Data Acquisition - Setting Sampling Intervals" on page 31).



1) Put the instrument into standby (by pressing the **POWER** key)
2) Then hold down the **STO** button while switching the instrument back **ON**. The LCD displays the message **`Sto`** for about one second
3) Normal gas concentration measurements are displayed for about two minutes
4) After two minutes the instrument displays the sample number (starting at **`000`**), then the gas concentration measurement value followed by **`[---]`** to indicate the measurement is being stored.
5) This storage sequence repeats automatically, at the rate specified by the WIN3654 program Sampling Rate menu. Values are stored sequentially in sample numbers **`000`** through **`499`**.

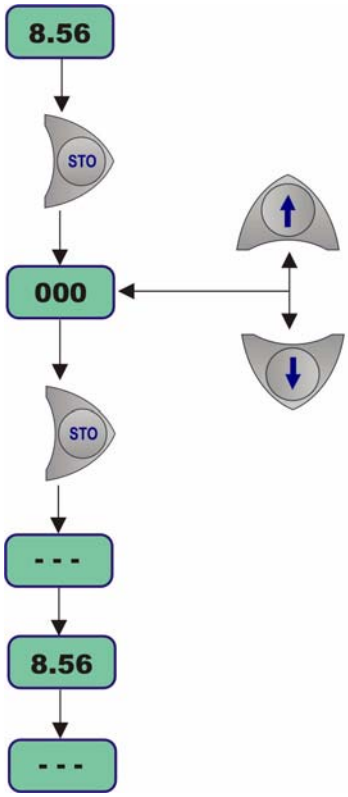
Note:
If you have not cleared previously stored values, the storage sequence automatically overwrites the older values, as they are stored.

To end automatic storage, put the instrument into standby (by pressing the **POWER** key) while it is in normal measurement mode and not while it is in the process of automatically storing data. Switching **ON** again without holding down the **STO** button returns the instrument to measurement mode.

Note:
*If you accidentally interrupt the automatic data storage by switching off the instrument while it is in the process of storing a value, and you then attempt to download the stored values by the WIN3654 program, you will get a Windows **Checksum Error** message, and you will not be able to view the measurement data. If this happens, go back to the instrument and manually log one more value (described in "Manual Data Acquisition"). You can then download your original set of values to your PC.*

2.3.2 Manual Data Acquisition

Note:
You cannot store measurement data manually if the instrument has already been set up to store the data automatically.

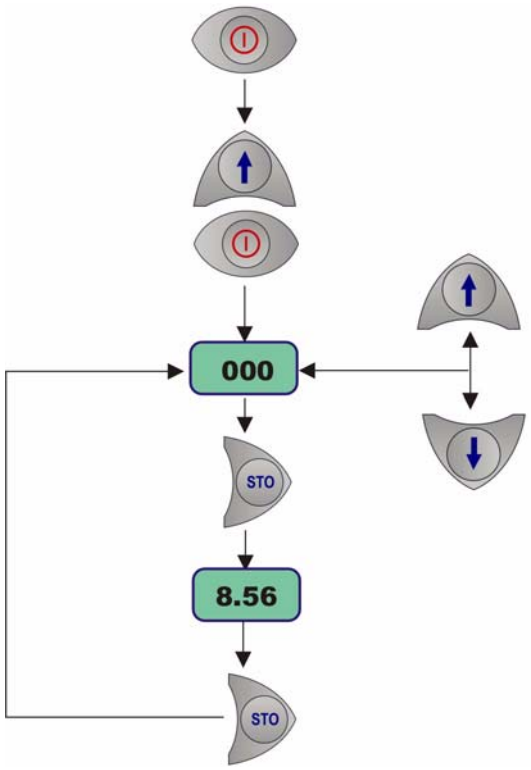


1) For the first measurement you wish to store, press the **STO** button once to display a sample number. The default sample number is **000** (for first time access), or the last used memory position where data was stored, incremented by a value of 1.
2) You can increase or decrease this number by pressing the **Up/Down Arrow** buttons within three seconds.
3) Should you decide at this point, not to store this particular measurement, just wait five seconds and the display returns to measurement mode. You may also exit this routine by pressing the **MEAS** button.
4) Press **STO** a second time, within five seconds of the first. The instrument then displays a brief clearing **[- - -]** message, followed by the gas concentration measurement value for about three seconds (e.g. **8.56** in the flow diagram)
5) The **[- - -]** message is displayed as this measurement value is stored
6) Repeat the above steps to store additional measurements.

If you stored the first value as sample **001**, the instrument automatically increases the next storage location, and labels it sample **002**. You can increase or decrease this number by pressing the **Up/Down Arrow** buttons.

Note:
If you label a sample number the same as a previously stored measurement value, the new measurement value overwrites the previously stored value.

2.3.3 Viewing Stored Measurements



1) Put the instrument into standby (by pressing the **POWER** key)
2) Hold down the **Up Arrow** button while switching the instrument back **ON**. The LCD displays a sample location number.
3) Scroll through the numbered sample locations of all the stored values using the **Up Arrow** and **Down Arrow** buttons.
4) To view the actual gas concentration measurement value at a particular sample number, press the **STO** button. The LCD now displays the stored value for that sample number.
5) Press **STO** a second time to return to the next numbered location display, to continue scrolling or view another stored value.

To return to the measurement mode, put the instrument into standby and then turn back **ON** again without holding down any additional buttons.

2.4 Storing and Accessing Measurements From a Computer

If you have made measurements and stored them in the analyzer, you should be ready to bring them into the WIN3654 program for viewing, copying, saving and printing. See also “Options Setup” on page 27 for additional information on the WIN3654 program.

2.4.1 Downloading Stored Values

To download the stored results from the analyzer to the PC, choose the **DownLoad** data command from the **Logger** menu.

The **DownLoad** window presents a display of the stored measurements from the instrument. The window displays five columns of data:

- Sample (sequence number of the sample)
- Conc (concentration of the measured gas)
- Date (date of the measurement)
- Time (time of the measurement)
- Sample Description

The descriptions can be modified for your applications using the procedures described below.

2.4.2 Altering the Sampling Point Descriptions

For help in identifying the locations of various sampling points that are stored by the analyzer, you may choose the **Sampling Point Description** command from the **Logger** menu to bring up the dialog box illustrated in Fig 2-2.

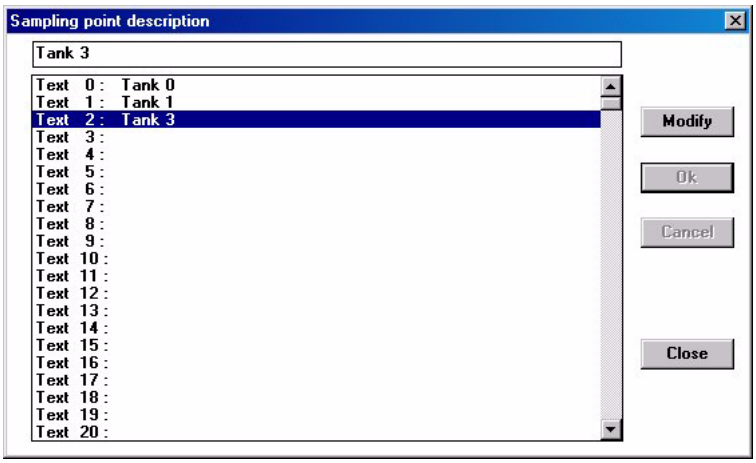


Fig 2-2: Sampling Point Descriptions

The measurement values to be placed in positions 0 through 499 (identified as Text 0, Text 1... etc.) can be described however you wish. Double-click on a particular position (or click **Modify**), then type a description of a maximum of 20 characters in the box as shown (e.g. **Tank 3**). Choose **OK** when finished entering a description.

When you **Close** this box, your modifications will be saved, and will appear in the **Sample Description** column for the ***next*** downloaded list. These descriptions can be modified again later as your requirements change.

2.4.3 Copying Values

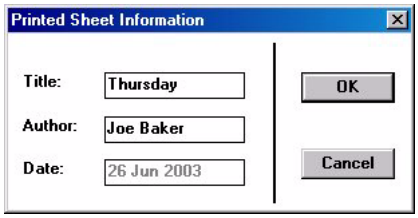
To copy the results to the Windows Clipboard, so that the data can be pasted into a spreadsheet, word processor or other Windows program that accepts tabular text information, choose the **Clipboard** command from the **Export** menu.

2.4.4 Saving Values

To save this list of measurements as a text (**.txt**) file, capable of being recalled by the WIN3654 program or imported as a file into other Windows programs, choose the **Save As** command from the **File** menu. A dialog box appears, with a space to fill in with an eight-letter name. (The program automatically attaches a **.txt** suffix to these files.) If you have saved previous files, a grayed-out list of these names appears as well.

Typical to Windows programs, **Directories** and **Drives** boxes can be used to locate other storage devices on which to store your data.

2.4.5 Printing Values



To place this list of measurements into a tabular format and send it to the Windows printer, choose the **Print** command from the **File** menu.

The program asks you to enter **Title** and **Author** information as illustrated left. The **Date** is fixed by your operating system.

The resulting printed list will include this information on each page.

2.4.6 Clearing Stored Values

To clear all the values stored in the analyzer via the WIN3654 program, choose the **Clear Data** command from the **Logger** menu. Since this action will clear the storage memory of the instrument, a warning appears first as shown left in Fig 2-3.

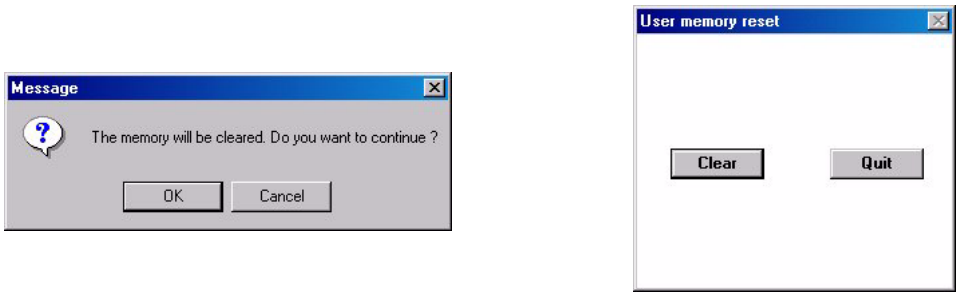


Fig 2-3: Clear Stored Values

Choose **OK** to bring up the next dialog box to confirm the clear action.

Choose **Clear** to start the memory clear operation. A message, **Reset should be completed** appears in this box when the task is finished.

Note:
You can accomplish the same thing passively, by simply allowing the analyzer to overwrite a set of stored values with new ones.

2.5 Monitoring Measurements In Real-Time

You may wish to analyze a particular sampling point via the WIN3654 program's **Monitoring** menu. To use this Monitoring chart, the analyzer must be connected to your PC.

Choose **Monitoring** from the WIN3654 menu to bring up a chart display like the one illustrated in Fig 2-4.

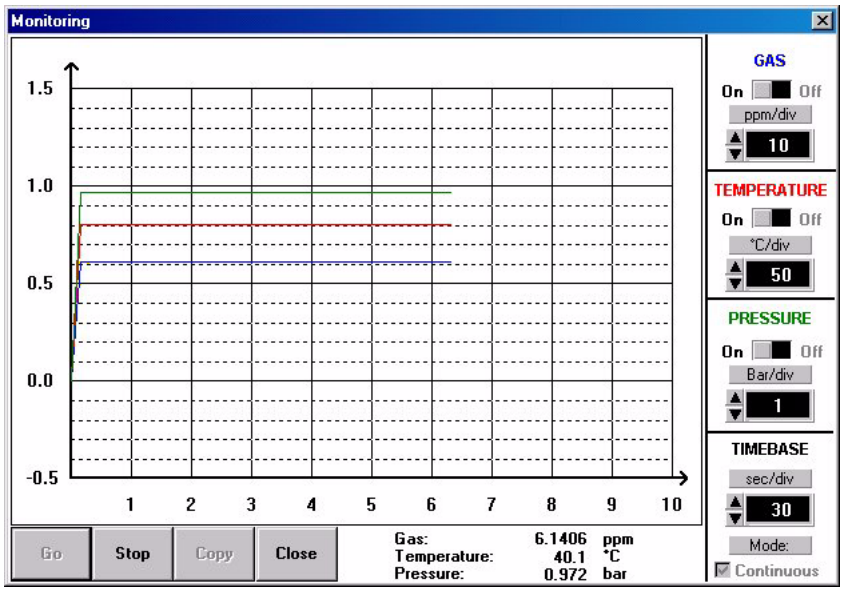


Fig 2-4: Real-Time Monitoring

The Monitoring chart shows the gas concentration (in blue), temperature (in red), and pressure (in green) as the sample is being measured by the 3654 instrument. The chart is updated directly from instrument measurements, at a rate determined by the time scale set in the **TIMEBASE** box at the lower right corner of the chart.

Click the **TIMEBASE** up/down pointers to change the time scale of the divisions of the chart. Each division mark along the baseline (1, 2, ...10) can be made to represent from 30 seconds to 2½ hours, providing from 5 minutes to 25 hours of continuously displayed samples. The chart updating rate is determined by the time scale selected, as shown in Table 2-1, “Chart Updating Rate,” on page 25.

Table 2-1: Chart Updating Rate

Timebase	Updating Rate*	Maximum Samples (10 divisions)
30 Seconds/Division	5 Seconds/Sample	60
1 Minute/Division	5 Seconds/Sample	120
10 Minutes/Division	5 Seconds/Sample	1,200
30 Minutes/Division	9 Seconds/Sample	2,000
1 Hour/Division	18 Seconds/Sample	2,000
2.5 Hours/Division	45 Seconds/Sample	2,000
*This chart's updating rate is independent from the acquisition rate (see “Automatic Data Acquisition - Setting Sampling Intervals” on page 31).		

Click on the **Continuous** box, in the lower right corner, to enable or disable continuous charting. When this box is checked, the chart scrolls continuously after reaching the **10** division, and the oldest samples are lost off the left of the chart. When **Continuous** is not checked, the chart stops displaying new results after reaching the **10** division, and all subsequent measurements are lost.

Click the up/down pointers for each measurement variable (**GAS**, **TEMPERATURE** and **PRESSURE**) at the right of the chart to change the scaling of that value on the chart. The display of each measurement variable may be turned on or off by choosing the appropriate **On** or **Off** switch at the right of the chart.

If your measurements do not chart properly, try using a higher or lower value scale or time base than the one displayed. Adjust these scale factors ***before*** starting the monitoring operation.

A running display of latest sample **Gas**, **Temperature** and **Pressure** is also shown in the bottom-right corner of the chart.

Use the buttons at the bottom of the chart to control real-time monitoring. Choose **Go** to clear the chart and start real-time monitoring display, **Stop** to stop real-time monitoring and **Copy** to copy the data from the chart as text information to the Windows Clipboard. This information can be pasted from the clipboard into any Windows application, such as a spreadsheet or word processor. See Table 2-1, “Chart Updating Rate,” on page 25 for the maximum number of samples that can be copied for each chart time scale.

Finally, choose **Close** to close the Monitoring window.

2.6 After Use and Storage

You can power off the instrument without losing setup or calibration parameters.

If measuring in a liquid sample, run clean warm water through the flow chamber after each series of measurements to prevent passages from clogging, and to keep the membrane clean.

The sensor must be continuously purged, if it is wet, to prevent any damage to the thermal conductivity sensing element. The instrument handles this automatically, even if switched off during short periods (for example overnight), provided it has a power supply (fully charged batteries or an external power supply) and a fully loaded purge gas cylinder.

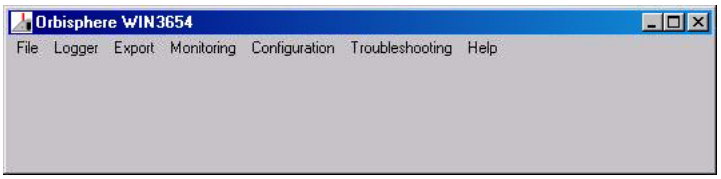
If you expect not to use your sensor for several days, flush all sample liquid out of the flow chamber, remove the flow chamber and dry it with a soft tissue. Dry the sensor head surface with a clean soft tissue to ensure no liquid is on the membrane or protection cap. Once dry, replace the sensor’s storage cap to protect it from any accidental damage. Store with a silica bag to prevent any humidity build-up.

3 Options Setup

The WIN3654 program is an integral part of the analyzer. Running under Microsoft Windows®, it permits you to list and analyze up to 500 stored measurement values. The program also includes a special monitoring feature, which lets your computer act as a chart recorder, and enables a hardware test to ensure that the system is in good working order.

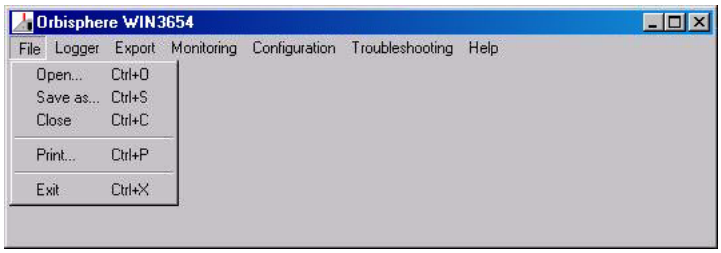
3.1 Main Menu Basics

When you start the program, it displays the **Main Menu**, which automatically maximizes on opening and appears as follows:



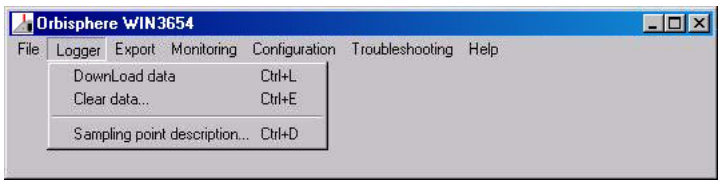
Throughout the WIN3654 program menus, you will see shortcut keys (such as Ctrl+P, to print a list of stored values). As you become familiar with the program, you may choose these keystroke commands for faster operation.

File, shown below, serves typical Windows file management needs.



WIN3654 data files can be opened, saved under a different name, closed, or printed. You can also exit the program.

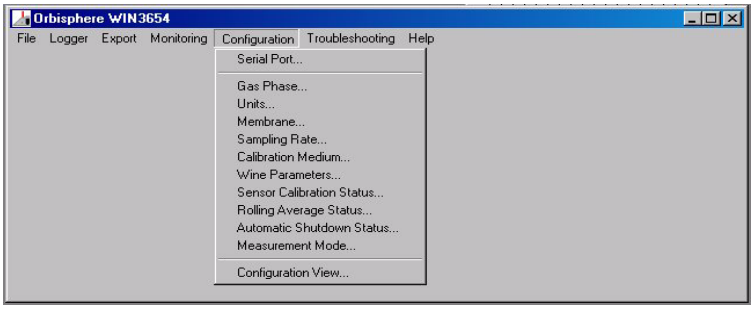
The **Logger** menu appears as follows. Here you can download measurement values from the instrument, make modifications to the sample list that can be used to identify sampling point locations, or clear the instrument's stored values.



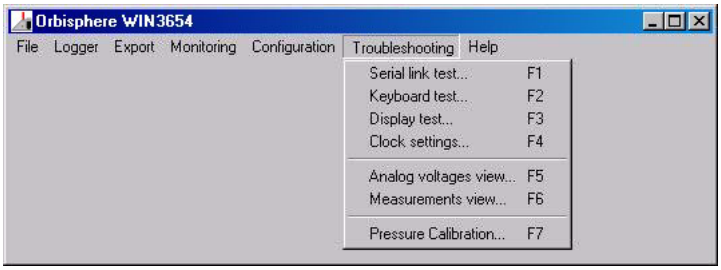
Export places your information into the Windows Clipboard, so that it can be pasted directly into other Windows programs. This is especially useful when working with spreadsheet or word processing programs.

The **Monitoring** menu creates a running chart of real-time measurements (see “Monitoring Measurements In Real-Time” on page 25). These values can also be saved to the Windows Clipboard.

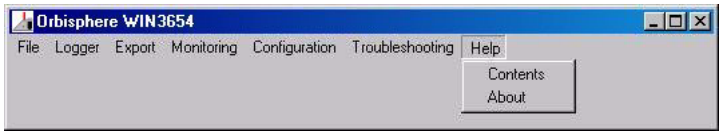
The **Configuration** menu lets you see how your system has been configured for your application. You may use this menu to change the configuration parameters should your application needs change.



The **Troubleshooting** menu includes a series of tests, allows you to set the clock, and enables a barometric pressure calibration routine.



Finally, the **Help** menu gives access to the Help file and displays the identification of the WIN3654 program (version number and copyright date).

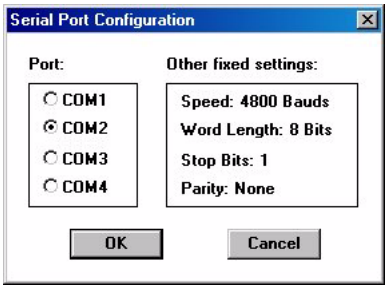


Note:
If the PC operating system is Windows Vista®, it may be necessary to download the Winhlp32.exe file from the Microsoft web site.

3.2 Analyzer - PC Connection

For the hardware connection of the analyzer to a PC, see “Instrument - PC Connection” on page 11.

The **Configuration**, **Serial port** menu lets you choose one of four serial communication ports, as follows:

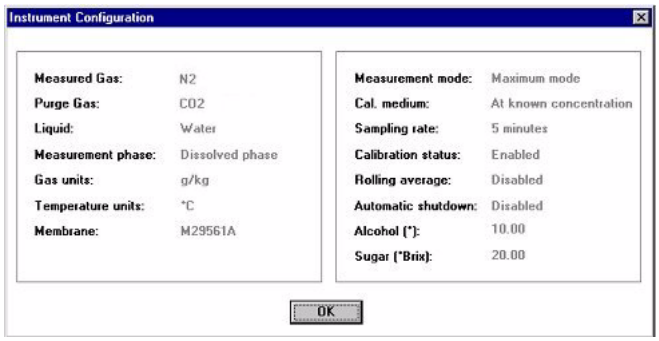


Usually, **COM1** is used to connect to a mouse, so try **COM2** first. You may find that a separate program supplied with your PC may be necessary to activate this port.

Click on **OK** to activate the selected port. If the port you have selected here is available, the WIN3654 program will return to the main menu. Otherwise, you will see an **RS232 ERRORS** message advising you to select another port.

3.3 Reviewing Instrument Configuration

To review if the analyzer is set up as expected, choose the **Configuration**, **Configuration view** command. You will see a window similar to the following:



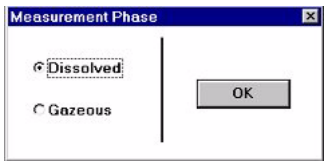
Some of the parameters listed, can be changed by using the WIN3654 program.

However, should you see any unexpected items listed on your screen that you cannot correct, contact your Hach Ultra representative.

3.4 Configuring the Instrument

The ORBISPHERE 3654 analyzer can be readily configured for your application using the following commands in the **Configuration** menu. The instrument must be connected to your PC and powered on, in order to change any configuration parameters.

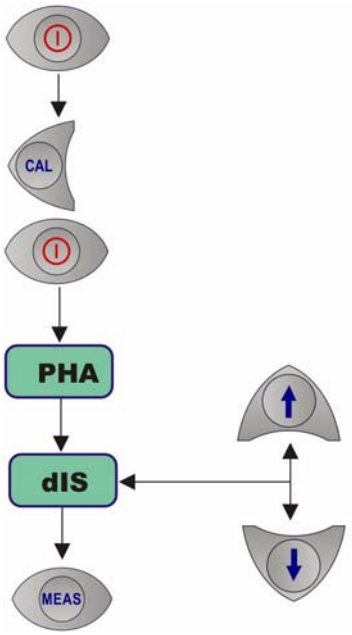
3.4.1 Gas Measurement Phase



The instrument can measure N_2 or H_2 in either a liquid or a gaseous sample, but you must select which gas phase to use.

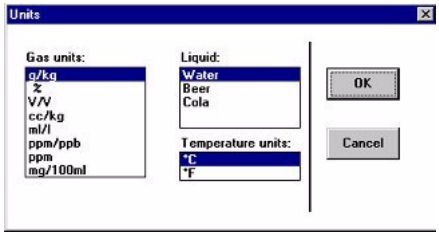
Choosing the WIN3654 program's **Configuration**, **Gas Phase** menu lets you select the gas measurement phase.

The gas measurement phase can also be selected from the instrument keyboard as follows:



1) Switch the instrument power **OFF**
2) Switch the instrument on by holding down the **CAL** button and then pressing the **POWER** button while still pressing the **CAL** button
3) The instrument display will first show **PHA** before switching to either **dIS** for dissolved or **gAS** for gaseous measurements
4) Use the **Up/Down Arrow** buttons to change the gas phase to your choice
5) Press the **MEAS** button to save the selected gas measurement phase. The instrument then goes to measurement mode

3.4.2 Measurement Units



Choose the **Configuration**, **Units** menu to select gas measurement units, temperature measurement units, and the liquid medium in which you are measuring.

You may change the LCD label on the instrument to match the new units selected.

Different LCD labels are supplied with the recharge kit.

Using this dialog box, you can select:

- The **Gas units** in which gas concentrations are to be displayed

  For dissolved measurements:

  g/kg, % (by weight), V/V, cc/kg, ml/l, ppm/ppb, ppm or mg/100ml

  For gaseous measurements:

  %/ppm (by volume), % (by volume), kPa/Pa, kPa, bar/mbar, bar, bar20/mbar20 or bar20

- The **Liquid** medium for dissolved gas concentration measurements

  Water, Beer or Cola

- The **Temperature units** for display

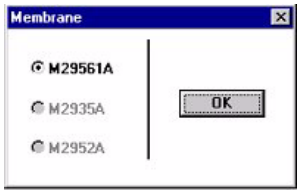
  °C or °F

3.4.3 Membrane Selection

You may find it necessary to use a different type of membrane for different applications. Naturally, with any membrane change, you will need to re-calibrate (see also “Sensor Calibration” on page 36).

You should also consider the changes in required flow rates and response times, which are listed in “Sensor Specifications” on page 56.

To re-configure the analyzer, choose **Configuration**, **Membrane** to bring up the box which reveals the membrane models available.



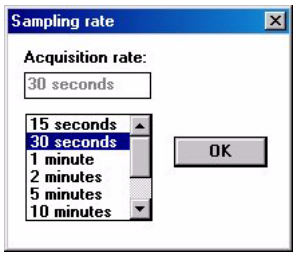
Membrane 29561A is available for any gas measurement. Membranes 2935A and 2952A are available for H_2 measurement only.

Choose **OK** when the desired membrane is selected.

Note:
Only those membranes applicable to your system can be selected. All other membranes are grayed out.

3.4.4 Automatic Data Acquisition - Setting Sampling Intervals

The analyzer can perform as a standalone data acquisition device, automatically recording gas measurements with the date and time, and storing up to 500 of these values. Choosing the WIN3654 program's **Configuration**, **Sampling Rate** menu lets you select time intervals (acquisition rate) for this storage capability.



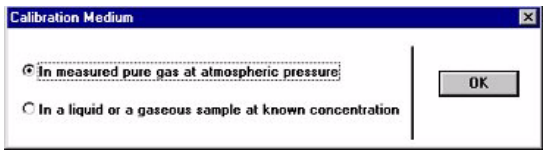
Use the slide bar to view and select a sampling rate, from 15 seconds to 1 hour. The selected rate is shown in the **Acquisition rate** window.

Click **OK** to save this rate. Once your choice is made, the analyzer can be used independently of the WIN3654 program for data acquisition, as described in “Automatic Data Acquisition” on page 20.

Note:
The Acquisition rate set via this menu is independent from the monitoring chart updating rate described in “Monitoring Measurements In Real-Time” on page 25. The sampling rate menu applies only to automatic data acquisition, while the chart updating rate is used only for displaying real-time results via the monitoring chart.

3.4.5 Calibration Medium

You can use the **Configuration**, **Calibration medium** command to select how the sensor is to be calibrated.



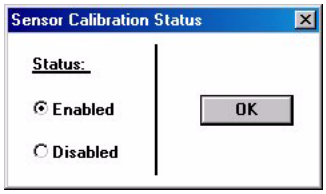
Choose either in pure H_2 or N_2 gas at atmospheric pressure or in a liquid or gaseous solution at a known concentration of gas.

Choose **OK** when the desired medium is selected.

Note:

You can create a solution having a known H_2 or N_2 concentration by dissolving H_2 or N_2 in water at a measured temperature and pressure. Hach Ultra can provide equipment for generating such a solution. Alternatively, you can analyze a carbonated beverage independently by other acceptable means.

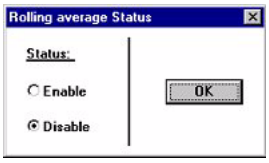
3.4.6 Locking Out the Instrument's CAL Button



You can use the **Configuration**, **Sensor Calibration Status** menu to prevent an accidental sensor re-calibration from the instrument keyboard.

Choose **Disabled** to lock out the keyboard **CAL** button. To unlock this capability, choose **Enabled**. Choose **OK** when the desired mode is selected.

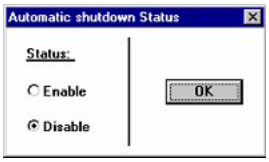
3.4.7 Rolling Average



Choose **Rolling Average Status** from the **Configuration** menu to enable or disable the averaging of gas concentration measurements.

To enable averaging on three successive gas measurements, choose **Enable**. Choose **Disable** to disable rolling average.

3.4.8 Automatic Shutdown

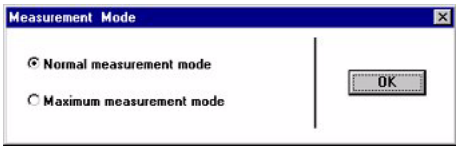


Choose **Automatic Shutdown Status** from the **Configuration** menu to activate the Automatic Shutdown feature.

If you select **Enable**, the instrument switches off automatically after 10 minutes of inactivity, thereby economizing battery power.

3.4.9 Measurement Mode

Choose **Measurement Mode** from the **Configuration** menu to enable maximum measurement mode for sampling in bottles and cans.



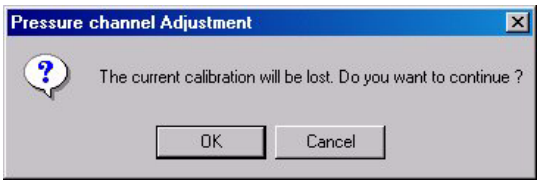
In **Maximum measurement mode**, the instrument searches for two consecutive measurements with less than a 2% difference, as also described in “Measurement Mode” on page 19.

When this occurs, the display is frozen and you may store the data. The instrument remains in this mode until you select **Normal measurement mode**.

4 Calibrations

4.1 Barometric Pressure Sensor Calibration

You must have access to an accurate barometer to calibrate the instrument's internal barometric pressure sensor. This is done using the PC WIN3654 program.



Choose **Troubleshooting**, **Pressure Calibration** and a message will warn that the current calibration will be lost.

Choose **OK** to continue.

The calibration procedure then displays a **Pressure Calibration** dialog box (as illustrated in Fig 4-1). The **Measured Pressure** value shows the current instrument pressure reading.

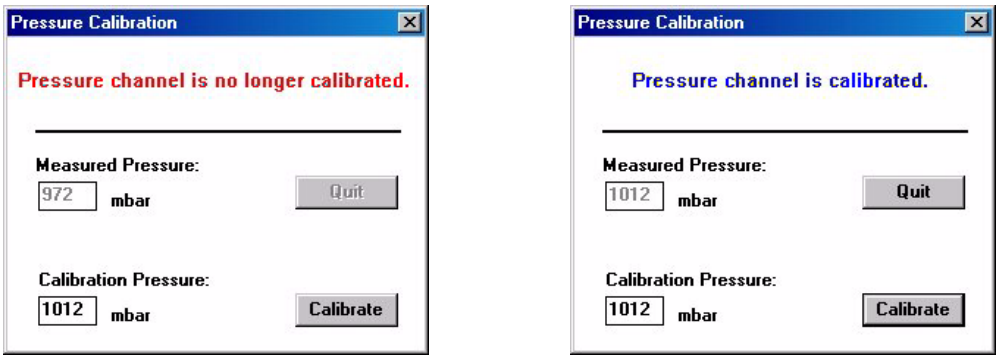


Fig 4-1: Pressure Calibration Screens 2 & 3

Enter the current atmospheric pressure, in mbars, in the **Calibration Pressure** entry box. Choose **Calibrate** to direct the instrument to read and display the **Measured Pressure** using this calibration value.

Choose **Quit** when you are satisfied with the pressure calibration to return to normal operation.

4.2 Sensor Calibration

The TC sensor can be calibrated in pure H_2 or N_2 gas at atmospheric or elevated pressure. The following table gives information regarding the different methods.

Table 4-1: Sensor Calibration Information

Calibration Method	Time	Benefits	Drawbacks	Reference
Gas at atmospheric pressure	5 min	Quick and easy	Less accurate than other methods	Gas with known purity, certified barometer
Gas at elevated pressure (2-3 bar)	10 min	Higher accuracy than atmospheric method. Validation of the sensor linearity	Requires a certified pressure gauge	Certified pressure gauge

Before calibrating check that the sensor membrane surface is tight, smooth and wrinkle free. Select the gas measurement phase for calibration (for full details see “Gas Measurement Phase” on page 29). Next, select the calibration medium using the WIN3654 program (see “Calibration Medium” on page 32).

Ensure that normal measurement mode is selected in the Measurement Mode menu of the WIN3654 program (see “Measurement Mode” on page 33).

Calibration must only be carried out once the TC sensor is giving a stable measurement. Expose the membrane to the calibration sample until this stable reading is obtained. This usually takes about 5 minutes.

For calibration it is important that the sensor's membrane is at the same temperature as the calibration sample. Therefore, allow some sample to pass through the flow chamber for 3 minutes before calibrating.

4.2.1 Calibration Setup

Ensure that the purge gas is flowing at the recommended rate through the sensor by placing the purge gas exit tubing into water. This rate should be more than four bubbles during the purge which lasts for 4 seconds.

This purge cycle is repeated every 20 seconds.

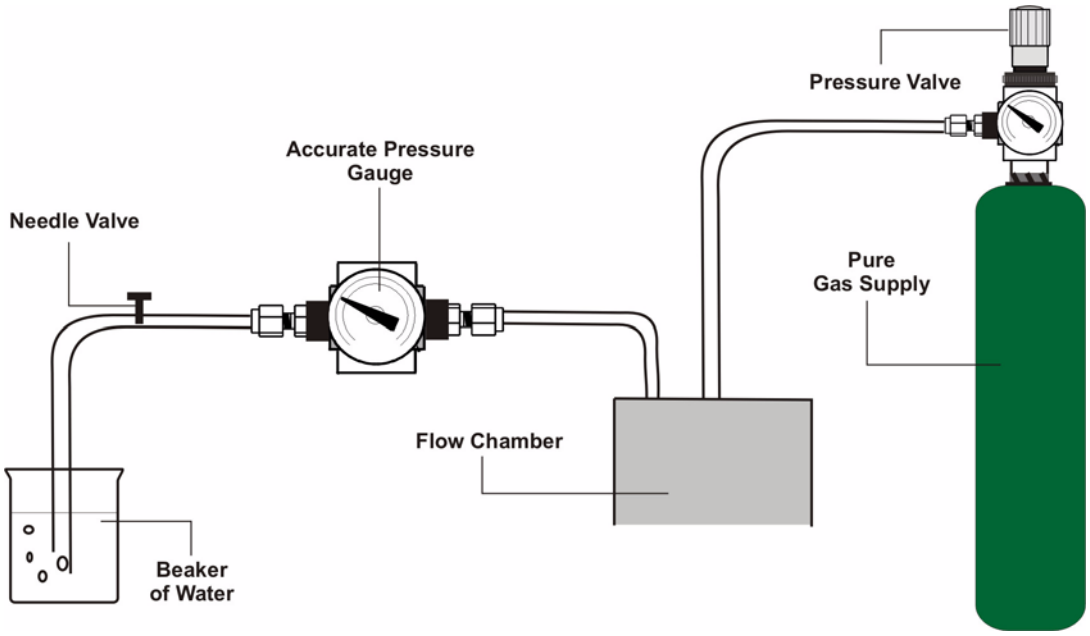


Fig 4-2: Calibration Setup Diagram

The calibration procedure requires a source of pure gas (regulated by a pressure valve) connected to the central entry port of the flow chamber, an accurate pressure gauge (better than ± 2%) at the exit of the flow chamber, a needle valve to control the flow on exit, and a beaker of water to monitor the gas flow. Fig 4-2 above illustrates the calibration setup.

4.2.2 Calibration In H_2 or N_2 at Atmospheric Pressure

The sensor can be calibrated in pure H_2 or N_2 gas at atmospheric pressure.

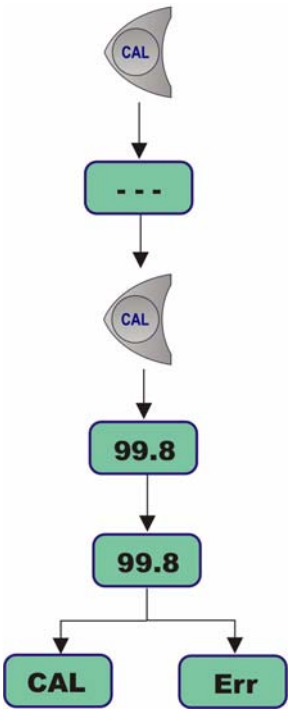
WARNING

Handle H_2 gas with great care. It is extremely flammable and explosive.

To ensure that the flow chamber and sensor components are dry, remove and blow dry the flow chamber. Dry the sensor head surface with a clean soft tissue.

The analyzer uses an internal barometric pressure sensor during this calibration. First check that the pressure sensor is correct and does not need recalibrating. If it does need to be recalibrated then follow the instructions in "Barometric Pressure Sensor Calibration" on page 35 before attempting this calibration.

1) Set the gas measurement phase to **Gaseous** and set the calibration medium to **In measured pure gas at atmospheric pressure** (as detailed in "Calibration Medium" on page 32).
2) Connect a source of pure H_2 or N_2 gas to the inlet of the flow chamber, as illustrated in Fig 4-2 on page 37, and adjust the gas flow to one bubble per second when the exit tube is immersed in water.
3) Press the **CAL** button. Remember, this button may have been locked out to prevent an accidental reset (see "Locking Out the Instrument's CAL Button" on page 32 for details).



4) Press the **CAL** button. Remember, this button may have been locked out to prevent an accidental reset (see "Locking Out the Instrument's CAL Button" on page 32 for details).
5) A brief clearing message **[---]** appears.
6) Press **CAL** again within a 3 second period.

   If the instrument makes two consecutive measurements with less than 1% difference, it calibrates against this stabilized value. The LCD then displays the message **[CAL]** to indicate calibration has been successfully completed

   If the calibration does not complete, the LCD displays the message **[Err]**. The reason for this calibration error is either that the measured gas partial pressure is under 5 mbar, or that a wrong instrument key was pressed during the calibration steps.

4.2.3 Calibration In H_2 or N_2 at Elevated Pressure

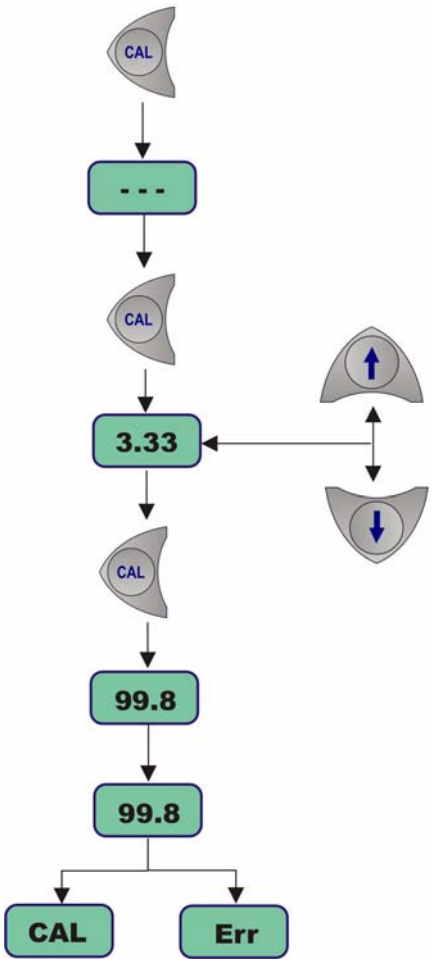
The sensor can be calibrated in pure H_2 or N_2 gas at an elevated pressure. This method requires an accurate pressure gauge connected to the exit of the flow chamber.

WARNING

Handle H_2 gas with great care. It is extremely flammable and explosive.

When calibrating in gas phase, the flow chamber and sensor head must be dry.To ensure that the flow chamber and sensor components are dry, remove and dry them with a clean soft tissue.

1) Set the gas measurement phase to **Gaseous** and set the calibration medium to **In a liquid or a gaseous sample at known concentration** (as detailed in "Calibration Medium" on page 32).
2) Connect a source of pure H_2 or N_2 gas to the inlet of the flow chamber, as illustrated in Fig 4-2 on page 37, and adjust the gas flow exiting from the flow chamber to be in the range of 1 to 5 bar (it is best to use a pressure close to the application conditions).



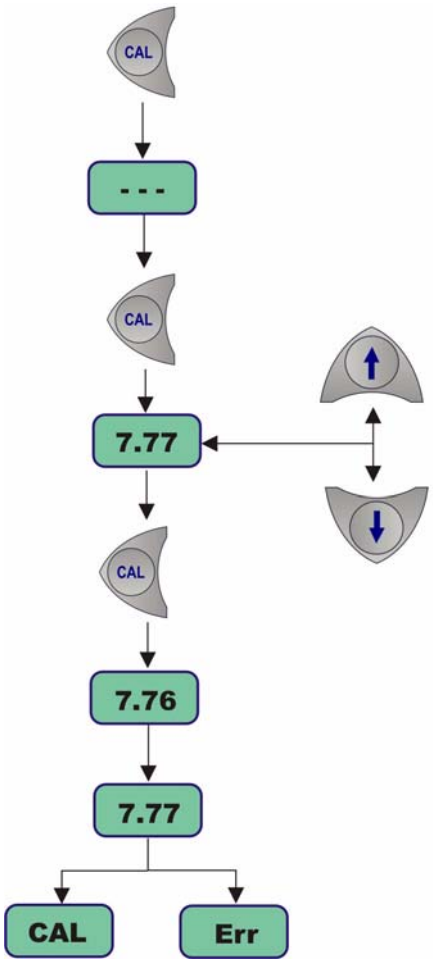
3) Press the **CAL** button. Remember, this button may have been locked out to prevent an accidental reset (see "Locking Out the Instrument's CAL Button" on page 32 for details).
4) A brief clearing message **[- - -]** appears.
5) Press **CAL** again within a 3 second period. The instrument then displays the absolute pressure of calibration gas (i.e. gauge pressure plus atmospheric pressure).
6) Modify this reading using the **Up/Down Arrow** keys until the displayed pressure agrees with that of the gauge plus atmospheric pressure.
7) Press **CAL** again.

   If the instrument makes two consecutive measurements with less than 1% difference, it calibrates against this stabilized value. The LCD then displays the message **[CAL]** to indicate calibration has been successfully completed

   If the calibration does not complete, the LCD displays the message **[Err]**. The reason for this calibration error is either that the measured gas partial pressure is under 5 mbar, or that a wrong instrument key was pressed during the calibration steps.

4.2.4 Calibrating In a Liquid H_2 or N_2 Solution

The sensor can be calibrated in a standard liquid solution that has a known concentration of H_2 or N_2. You can create a solution with a known concentration by dissolving H_2 or N_2 in water at a measured temperature and pressure. Alternatively, analyze a carbonated beverage independently by some acceptable means.



1) Set the gas measurement phase to **Dissolved** and set the calibration medium to **In a liquid or a gaseous sample at known concentration** (as detailed in "Calibration Medium" on page 32).
2) Press the **CAL** button. Remember, this button may have been locked out to prevent an accidental reset (see "Locking Out the Instrument's CAL Button" on page 32 for details).
3) A brief clearing **[- - -]** message appears.
4) Press **CAL** again within a 3 second period. The instrument then displays the concentration of H_2 or N_2, based on the last value of the calibration coefficient.
5) Modify this reading using the **Up/Down Arrow** keys until the displayed concentration agrees with that of the calibration solution.
6) Press **CAL** again.
7) Start the flow of the standard (calibration) solution through the flow chamber. Adjust the flow until the liquid is foam-free. The flow rate should be a minimum of 150 ml/min and be stable.

Note:
A flow rate lower that 150 ml/min can be used for the calibration, but you must ensure that all measurements made after the calibration are made at exactly the same flow rate as is used for the calibration. To ensure accurate results it is recommended to use a model 32311 Flow Meter as described in "Model 32311 Flow Meter" on page 41.

If the instrument makes two consecutive measurements with less than 1% difference, it calibrates against this stabilized value. The LCD then displays the message **[CAL]** to indicate calibration has been successfully completed

If the calibration does not complete, the LCD displays the message **[Err]**. The reason for this calibration error is either that the measured gas partial pressure is under 5 mbar, or that a wrong instrument key was pressed during the calibration steps.

5 Accessories and Attachments

5.1 Model 32311 Flow Meter

A flow meter is available as an option, to attach to the top of the flow chamber, instead of the flow rate adjustment valve usually supplied. This can be used to set an accurate flow rate of the sample. This is especially useful with small volume packages such as small cans and bottles.

This flow meter simply replaces the standard adjustment valve, as illustrated in Fig 5-1 below.

Fig 5-1: Standard Adjustment Valve (left) and Flow Meter (right)

If using this flow meter option, you must ensure that you first recalibrate the instrument with the flow meter attached before you take any measurements. In addition, any measurements made must be made using exactly the same flow rate setting as used for the calibration.

The recommended flow rate should be set at 50%, though a minimum flow rate (for small volume packages) of 30% can be used. To set the flow rate, adjust the knob at the top of the flow meter until the **center point** of the bead indicates the desired flow rate.

5.2 Model 32939 External Power Supply

Provided you have a clean external power supply, you can connect the power directly to the instrument, using this accessory, via the RS-232 port on the instrument (as illustrated in Fig 1-1 on page 9).

Fig 5-2: Model 32939 Power Supply

The male LEMO-6 (to the right on the illustration above) attaches directly to the instrument. The female LEMO-6 (to the left on the illustration above) can be used to attach the instrument to your PC. The other connection is to the transformer (illustrated to the top) which in turn is connected directly to your power supply.

6 Maintenance and Troubleshooting

6.1 Power Supply

It is important to maintain power to the instrument at all times, (either batteries or an external power supply) to ensure the sensor is continually purged and so prevent damage to the TC sensor chip.

If the 3654 instrument is operating on battery power (two standard C-type cells), and the battery power should drop, a **[LO BAT]** warning message is displayed in the instrument LCD's top left corner.

To install the batteries, unscrew the battery cap (on the right side of the instrument) with the tool provided in the recharge kit, or with a coin or flat bladed screwdriver. Place the cells lengthwise into the battery compartment (positive end first), and then replace the cap. Refer to the diagram on the back of the instrument.

Rechargeable nickel-cadmium batteries may be used. Expect about 15 hours of autonomy in continuous operational use, or 3 weeks in standby (with purge gas supplied). Alkaline batteries provide the longest continuous use though mercury-free batteries are available that present less of a disposal problem.

Make sure that a fully charged (or fresh) set of batteries is installed before switching on the instrument.

6.2 Sensor Maintenance

6.2.1 Maintenance Schedule

Sensor maintenance includes membrane replacement and external cleaning to restore the original sensor sensitivity. This means low running costs and down time reduced to a minimum.

The membrane needs to be replaced once or twice a year depending on application conditions. This can be tailored accordingly.

Note:
If you are not familiar with Orbisphere sensor servicing, your Hach Ultra representative will be glad to assist you

6.2.2 Testing the Sensor Condition

Periodically, visually inspect the sensor head for any deposits. Rinse it under clean tap water, and dry with a clean tissue.

To verify the sensor, check measurements vs. a known standard sample value:

- If reading deviation is ±1% of the expected value, no action needs to be taken.
- If deviation exceeds ± 1%, perform a new calibration.
- If deviation exceeds 10% of the original values, replace the membrane.

CAUTION:
Carry out the maintenance in a clean dry place in order to avoid damaging the sensor's precision components, and also to prevent water or humidity from getting into the sensor.

6.2.3 Mounting Dual Membranes

In order to prevent unwanted stretching of the membrane on a hydrogen sensor it is recommended to simultaneously mount a support membrane beneath the primary membrane.

The primary membrane, or top membrane, determines the rate at which the H_2 gas enters the measurement chamber of the sensor. The secondary membrane, or support membrane on the bottom, is extremely permeable and is installed to stabilize the position of the primary membrane.

Two primary membrane types are used for H_2 measurement depending on the type of application:

- **29561A** - used for waste gas, off gas and dH_2 in a boiling water reactor
- **2952A** - used for dH_2 in reactor cooling systems of a pressurized water reactor.

The support or secondary membrane for all H_2 measurement applications is the **29562A**.

As two membranes will be mounted together, the mounting ring used must be part number **29229** which is designed for a thickness of 50 microns or more. Mounting ring part number 29228 is designed for a single membrane and should not be used for mounting dual membranes.

6.3 Membrane Replacement

Note:
After replacing a membrane, the sensor must always be re-calibrated. Allow the sensor to settle for 30 minutes in measurement phase to allow measurements to stabilize, before performing the sensor calibration.

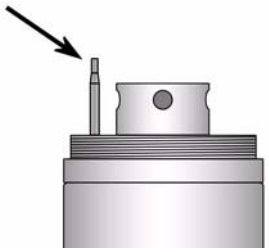
6.3.1 Removing the Membrane

It is recommended to leave the sensor in place in the instrument when changing the membrane. It is not necessary to remove it.

To remove the membrane, follow the steps below:

First remove the flow chamber from the sensor by turning the flow chamber locking pin (see position in Fig 1-1 on page 9) counter-clockwise and gently lifting the flow chamber off the sensor.

CAUTION:
A thermistor at the top of the sensor (illustrated right) is used to measure the sample temperature. Do not bend or damage this component by trying to twist the flow chamber off the sensor.



Unscrew the protection cap, using the tool provided in the maintenance kit.

CAUTION:
Never remove the protection cap, unless you plan to replace the membrane.

Pull up the membrane holding ring with the tool provided in the maintenance kit.

Remove the old membrane and discard it.

6.3.2 Installing the Membrane

To install the new membrane, follow the steps below:

Note:
The membrane mounting surface must be clean and even (on top of the sensor, where the membrane and sensor have contact).

Replace the membrane O-ring on the sensor head with a new one.

Note:
The 29039.0 Nitril O-ring can be reused if it is still in good condition. Membrane O-rings are part of the protection cap kit.

In the maintenance kit, pick up the two part membrane mounting tool.

Install the sleeve over the sensor head (end with shoulder downwards).

Note:
Once installed, a membrane cannot be reused. Avoid touching the membrane with bare fingers, as this may affect its sensitivity.

To mount a **single** membrane:

- Take a few membranes out of the storage box.
- Using tweezers included in the kit, pick up one membrane from the stack, and gently place it on the sensor tip.
- Make sure it is centered.

To mount **dual** membranes:

- Remove one 29562A secondary membrane along with one piece of the separation paper from its box. Place the membrane and paper, paper side down, on a clean flat surface.
- Remove a primary membrane along with its separation paper.
- With the separation paper on top of the primary membrane place the primary membrane directly over the secondary membrane, taking care to center the two membranes.
- Rub your finger on the paper of the primary membrane to remove any air bubbles between the membranes. The two membranes should now be sandwiched together and appear as one membrane.
- Pickup the sandwiched membranes with tweezers and remove the separation paper.
- Gently place them on the sensor tip ensuring the secondary membrane (29562A) is on the bottom.
- Make sure they are centered.

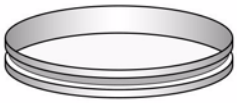
Note:
Distinguish the membrane from the protection paper:
- Membrane is transparent (translucent).
- Protection paper is opaque.

The membrane diameter is larger than the sensor head diameter. This is normal, as the membrane will fold over the sensor tip.

The membrane holding ring comes in two slightly different internal diameters, depending on the membrane(s) total thickness.

For a correct membrane installation, be sure to use the correct holding ring for the application.

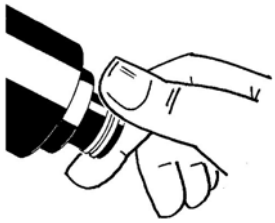
If mounting dual membranes, always use mounting ring part number 29229.



29228.01 holding ring:
membrane thickness < 50 µ

29229.01 holding ring:
membrane(s) total thickness ⩾ 50 µ

Place the membrane holding ring on the installation tool tip.



CAUTION:
To avoid damaging the membrane, make sure that the tool tip is totally clean and its surface is even.

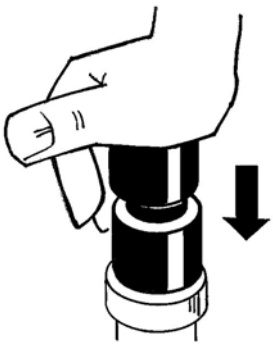
Insert the installation tool inside the guiding sleeve.

Push the installation tool firmly downwards. This clasps the mounting ring onto the sensor head, folding the membrane over the sensor tip.

Remove the installation tool and guiding sleeve.

Visually check for correct ring placement, try to push it down with your fingers.

Check that the membrane is tight, with no wrinkles.



Clean and dry the protection cap ready for installation.

Replace the O-ring inside the protection cap with a new one. Tighten the protection cap finger tight.

Then, complete the process using the tool provided in the maintenance kit. Insert into each of the four holes in turn, and tighten as as possible. Tighten each hole only once.

Finally replace the flow chamber.

Gently lower the flow chamber onto the sensor, guiding the thermistor on the sensor into the hole in the flow chamber base.

Turn the flow chamber locking pin (see Fig 1-1 on page 9) clockwise to secure it in place.

CAUTION:
The thermistor is used to measure the sample temperature. Do not bend or damage this component.

Check that the membrane has not been damaged. The alarm message **"ERR"** will be displayed on your analyzer if the membrane leaks in any way.

6.4 Purge Gas Cylinder Refill

The analyzer uses one of two types of purge gas:

- N_2 purge gas for H_2 measurements
- CO_2 purge gas for N_2 or H_2 measurements

You will need a model 32824A refilling hose to refill the purge gas cylinder.

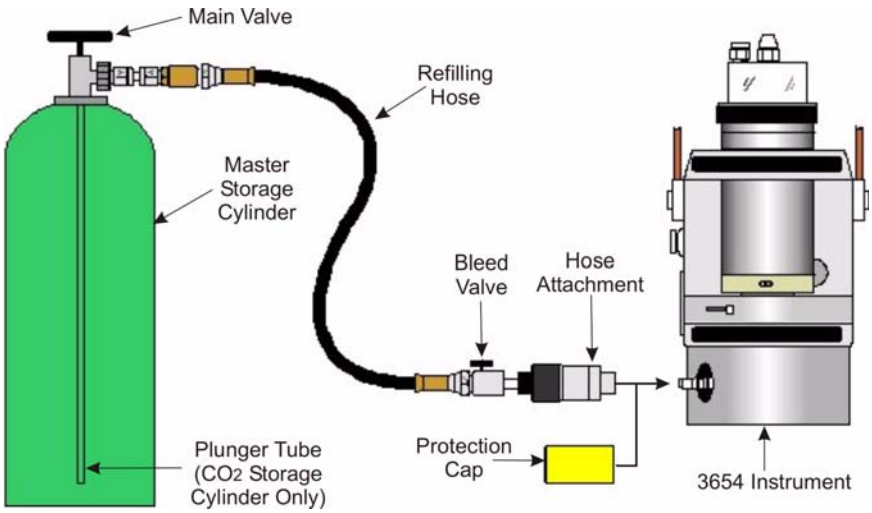


Fig 6-1: Purge Gas Cylinder Refill

CAUTION:
Only trained personnel should perform this filling operation. These persons should be aware of safety procedures furnished by the storage gas supplier, and any applicable regulations issued by local health and safety authorities.


Always wear safety glasses and gloves when performing any refill operation.

6.4.1 N_2 Purge Gas

Fill the **N_2 purge gas cylinder** to a maximum of 200 bar from a master N_2 storage cylinder, using fittings supplied with the analyzer.

CAUTION:
Although N_2 is not toxic, it is asphyxiating. Therefore, filling should be carried out in a ventilated place and leaks should be avoided.

Note:
Do not attempt to refill the analyzer purge gas cylinder if the master N_2 storage cylinder pressure is below 100 bar. When the master cylinder is below this pressure, refill or replace the master cylinder.

6.4.2 CO_2 Purge Gas

Fill the **CO_2 purge gas cylinder** to a maximum of 57 bar (liquid phase at 20°C) from a master CO_2 storage cylinder equipped with a plunger tube, using fittings supplied with the analyzer.

WARNING

CO_2 is toxic, asphyxiating, and heavier than air. Therefore, filling should be carried out in a ventilated place and leaks should be avoided.

6.4.3 Filling the Purge Gas Cylinder

The process for filling the purge gas cylinder is identical regardless of which purge gas you are using. For important information relevant to the different purge gases, refer to the two sections above.

Refill the purge gas cylinder in a clean and dry area as follows, referring to the illustration in Fig 6-1 on page 48 for more information:

1) Connect the **refilling hose** (model 32824A) to the **master storage cylinder**.
2) Close the **bleed valve** on the **refilling hose**.
3) Carefully, open the **main valve** on the **master storage cylinder**.
4) Close the **main valve** on the **master storage cylinder**.
5) Open the **bleed valve** on the **refilling hose** to purge the hose.
6) Close the **bleed valve** on the **refilling hose**.
7) Remove the **protection cap** from the instrument base.
8) Connect the **refilling hose** to the instrument. This is a push-on connector, so make sure that the connector clicks into the instrument fitting.

Note:

*Position the instrument below the outlet of the **master storage cylinder**.*

9) Carefully open the **main valve** on the master cylinder and wait about 30 seconds for the refilling process to finish.
10) Close the **main valve** on the **master storage cylinder**.
11) Open the **bleed valve** on the **refilling hose** to purge the hose.
12) Carefully, disconnect the **refilling hose** from the instrument by sliding the **hose attachment** in the direction shown (toward the instrument) and pulling back the connector.
13) Replace the **protection cap** on the instrument.

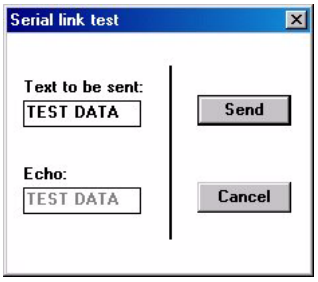
6.5 Troubleshooting - Instrument

If your analyzer is behaving strangely (failing to calibrate, giving inappropriate measurement values, etc.) and you have attempted to rectify the problem by servicing the sensor (for instructions, see “Sensor Maintenance” on page 43) but to no avail, you may wish to use the WIN3654 **Troubleshooting** menu to make sure that the instrument is configured correctly for your application, and is in good working order.

The instrument must be connected to your PC and placed in measurement mode to perform these tests.

6.5.1 Serial Test

Normally, the instrument will inform you of a disconnected RS-232 (serial) link when appropriate. However, you can confirm a good connection using the **Troubleshooting**, **Serial Link Test** by echoing a test message via the instrument.

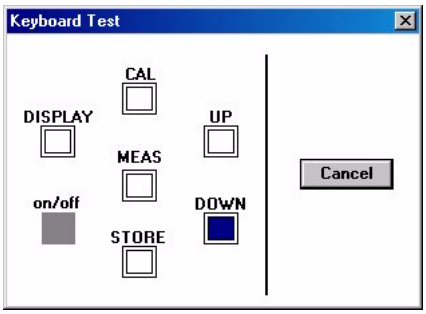


Enter text characters in the **Text to be sent** box, then click **Send**. If the serial link is operating correctly, the exact same text will be displayed back from the instrument in the **Echo** box.

Any difference in text indicates a possible problem with the serial communications.

Choose **Cancel** to exit from this test box.

6.5.2 Keyboard Test



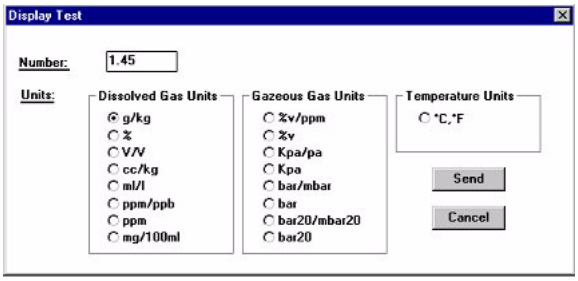
The **Troubleshooting**, **Keyboard Test** will reveal whether all the analyzer buttons are functioning correctly.

Press any one of the instrument's buttons (***except*** the **on/off** button) for a full second or more. The appropriate square on-screen should darken (as illustrated for the **Down Arrow** button).

Choose **Cancel** to exit from this test box.

6.5.3 Display Test

Choosing **Troubleshooting**, **Display Test** lets you perform a one-way communication between computer and instrument.

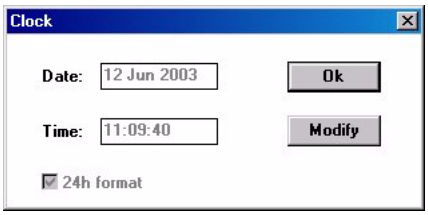


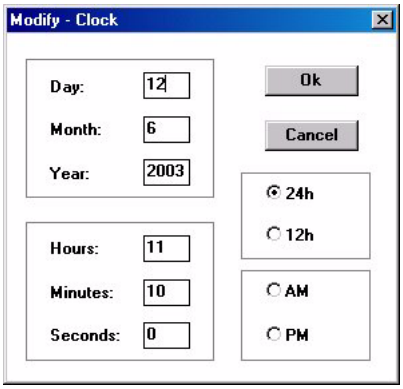
Type a number (with or without a decimal point) in the **Number** box, select the measurement **Units**, and then click **Send**.

The number entered and the indicator bar placement, should appear on your instrument LCD.

6.5.4 Clock Settings

Choose the **Clock settings** command to set the date and time in the instrument.



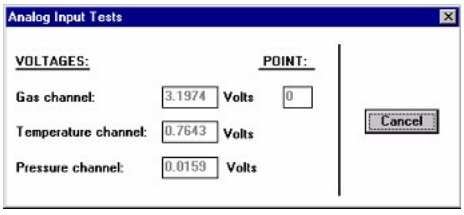


The first screen displays the current date and time as set in the instrument. If this is correct, choose **Ok**, else if either date or time must be changed, choose **Modify** to bring up the next screen.

Enter the current date and time and choose **Ok** to store the entry into the instrument. All measurements will be noted with the appropriate date and time when they are downloaded to the WIN3654 program.

6.5.5 Analog Voltages View

The **Troubleshooting**, **Analog Voltage View** gives a real-time look at voltages used by the system to transmit information about gas, temperature and pressure. This is useful when trying to identify an instrument problem with a Hach Ultra service representative either on-site or over the phone.



When performing this test, if the system is over-range, you may receive a message that states, for example, **The current input is saturated**.

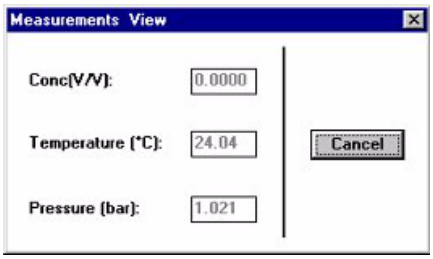
Similar messages will also appear, to warn when temperature and pressure limits are exceeded.

The voltage limits for normal operation are:

- Gas channel: between +0.1 V and +4 V, depending on the gas being measured
- Temperature channel: +10 mV to +4 V
- Pressure channel: -100 mV to +100 mV

The **POINT** window on the right side of the gas channel voltage, is a parameter useful for troubleshooting by Hach Ultra support technicians. It cannot be set or updated locally.

6.5.6 Measurements View



The **Troubleshooting**, **Measurements View** confirms, on your PC monitor, what your analyzer should be displaying on the LCD for gas concentration and sample temperature.

Choose **Cancel** to exit from this display.

6.6 Troubleshooting - Operation

6.6.1 Program Identification

In case of problems, it may be necessary to check the current version of your software as this may be required by Hach Ultra if you need to contact them for assistance in problem solving.

To identify the version of the software in your instrument, switch off the instrument. Then hold down the **MEAS** button while switching the instrument back on. The instrument will then briefly display the software version number before going through it's start-up procedures.

6.6.2 Diagnostics Messages

The following are warning messages that may appear on the instrument LCD in place of the gas concentration.

Table 6-1: Diagnostic Messages

Message	Meaning
Pur	This message appears on the LCD if the purge gas supply fails. To detect this condition, the voltage signal from the TC sensor is measured. This is normally between 1-3 volts, depending which gas is being measured. If the flow of purge gas stops, the sensor voltage wanders outside the permitted range of 100mV to 4 V. See also "Continuous Purge" below.
Out	This message appears if the sensor is unplugged from its correct position, or if the temperature is outside the range -5°C to 100°C.
Err	During start-up, this message indicates the instrument cannot complete the start-up tests successfully (see "Taking Measurements" on page 19). If the problem persists, contact your local Hach Ultra service representative for assistance.
	During calibration, this message indicates that the partial pressure of gas is below the acceptable range (<5 mbar), or that you have pressed a wrong key, as explained in "Sensor Calibration" on page 36.

6.6.3 Continuous Purge

It may be useful, particularly when seeing a **[Pur]** error message on your display, to view the purge voltage of the TC sensor in a continuous purge mode. In this mode, there is no purge/measurement cycle, as the purge gas is flowing through the sensor continuously.

To start continuous purge mode, put the instrument into standby, then hold down the **Down Arrow** button while switching the instrument back on again. The instrument displays **[Pur]**, followed by the purge gas voltage.

At 20-25°C, this voltage should be about 3.00V (± 200 mVolt) for H_2/N_2 measurements.

To exit from continuous purge mode, put the instrument in standby, then switch back on again without holding any keys.

6.6.4 Troubleshooting Table

Table 6-2: Troubleshooting Table

Symptom	Cause	Possible Solution
Unstable measurement	Degassing	Adjust sample flow rate
	Flow chamber and/or membrane not clean	Clean system
	Sensor's membrane not tight smooth and wrinkle free	Replace membrane and recalibrate
	Leaking solenoid valve	No gas bubbles should escape from the purge gas outlet during measurement. If the solenoid leaks (more than 1 bubble in 15 seconds) contact your Hach Ultra representative.
	An external power supply is used but the power supply is not clean	Switch to battery power
Low readings	Sample flow rate too low	Check flow rate
	Degassing	Adjust forcing gas and/or sample flow rate
	Membrane is not at sample temperature	Allow sample to flow past the membrane to make sure the membrane is at sample temperature before making measurements
	Membrane not clean	Clean system
	Incorrect solubility curve	Change solubility
	Incorrect calibration	Recalibrate
High readings	Membrane is not at sample temperature	Allow sample to flow past the membrane to make sure the membrane is at sample temperature before making measurements
	Incorrect solubility curve	Change solubility
	Incorrect calibration	Recalibrate

7 Specifications

7.1 Instrument Specifications

Table 7-1: General Technical Data

Power Requirements	Batteries: two C-type cells, NiCad or alkaline, each 26 mm x 50 mm, 2.4 to 3 volts total
Battery Autonomy	15 hours operational use, 3 weeks purge backup (power off, purge gas supplied)
Dimensions (HxWxD)	19.8 x 11.5 x 22 cm
Weight (including purge gas cylinder and sensor)	4.6 kg
Purge Gas	Nitrogen (H_2 sensors) Carbon Dioxide (N_2 and H_2 sensors)
Purge Gas Cylinder Pressure Limit (see also Note below)	200 bar maximum for N_2 purge gas 60 bar maximum for CO_2 purge gas
Purge Gas Autonomy	40 hours when cylinder filled to 200 bar of N_2 20 hours when cylinder filled to 100 bar of N_2 120 hours when cylinder filled with 75% of CO_2 liquid
Capacity of Purge Gas Cylinder	65 ml
Digital Output (RS232C)	Baud rate: 4800 Data bits: 8 Stop Bits: 1 Start Bits: 0 Parity: None
Measurement Cycle Time	20 seconds
Temperature of Use	0 to 40°C (32 to 104°F)
Temperature of Sample	-5 to 35°C (23 to 95°F)
Sample Pressure Limit (32013A and 32015 flow chambers)	< 10 bar, at <= 25° C
Enclosure Protection	IP 67
CE Certification	EN 61326-1:1997 /A1:1998 /A2:2001 /A3:2003 Directive 89/336/CE

Note:
*In accordance with the **Pressure Equipment Directive 97/23/EC (Article 3.3)**, the components that make up the purge gas cylinder and pressure reducer, are not subject to the technical requirements of this directive.*

7.2 Sensor Specifications

Table 7-2: Sensor Specifications - Table 1

Sensor Type	31 270 H_2		
Membranes	29561A	2952A	2935A
Thickness	25 µm	25 µm	25 µm
Membrane material	PFA	ETFE	ECTFE (Halar)
Recommended applications	Waste gas offgas, reactor coolant	Reactor coolant	High H_2 level
Radiation limits	10^5 rad	10^8 rad	10^8 rad
Measurement range at 25°C	0-1.5 ppm, or 0-16 cc/kg, or 0-1 bar	0-5 ppm, or 0-60 cc/kg, or 0-3 bar	0-15 ppm, or 0-180 cc/kg, or 0-9 bar
Accuracy (sample temp. 20-50°C within ± 5°C of calibration temperature)	The greater of ±1% of reading or ± 4 ppb, or ± 0.06cc/kg, or ± 3 mbar	The greater of ±1% of reading or ± 16 ppb, or ± 0.2cc/kg, or ± 12 mbar	The greater of ±1% of reading or ± 45 ppb, or ± 0.5 cc/kg, or ± 30 mbar
Accuracy (sample temp. 0-50°C independent of calibration temperature)	The greater of ±2% of reading or ± 30 ppb or ± 0.35 cc/kg or ± 12 mbar	The greater of ±2% of reading or ± 120 ppb or ± 1.2 cc/kg, or ± 40 mbar	The greater of ±2% of reading or ± 300 ppb or ± 3.0 cc/kg, or ± 100 mbar
Measurement cycle (sec.)	20		
Sample flow rate (through flow chamber)	200 ml/min	100 ml/min	50 ml/min

Table 7-3: Sensor Specifications - Table 2

Sensor Type	31 272 H_2			31 570 N_2
Membranes	29561A	2952A	2935A	29561A
Thickness	25 µm	25 µm	25 µm	25 µm
Membrane material	PFA	ETFE	ECTFE (Halar)	PFA
Recommended applications	Waste gas and offgas	Waste gas offgas, reactor coolant	Reactor coolant and High H_2 level	Beverage
Radiation limits	10^5 rad	10^8 rad	10^8 rad	10^5 rad
Measurement range at 25°C	0-0.075 ppm, or 0-8 cc/kg, or 0-0.5 bar	0-2.5 ppm, or 0-30 cc/kg, or 0-1.5 bar	0-7.5 ppm, or 0-90 cc/kg, or 0-4.5 bar	0-250 ppm, or 0-200 ml/L, or 0-15 bar
Accuracy (sample temp. 20-50°C within ± 5°C of calibration temperature)	The greater of ±1% of reading or ± 2 ppb, or ± 0.03 cc/kg, or ± 2 mbar	The greater of ±1% of reading or ± 8 ppb, or ± 0.1cc/kg, or ± 6 mbar	The greater of ±1% of reading or ± 25 ppb, or ± 0.25 cc/kg, or ± 15 mbar	The greater of ±2% of reading or ± 0.5 ppm, or ± 0.5 ml/L, or ± 30 mbar
Accuracy (sample temp. 0-50°C independent of calibration temperature)	The greater of ±2% of reading or ± 60 ppb or ± 0.7 cc/kg or ± 25 mbar	The greater of ±2% of reading or ± 250 ppb or ± 2.5 cc/kg, or ± 80 mbar	The greater of ±2% of reading or ± 600 ppb or ± 6.0 cc/kg, or ± 200 mbar	The greater of ±4% of reading or ± 2 ppm, or ± 1.6 ml/L, or ± 70 mbar
Measurement cycle (sec.)	20			
Sample flow rate (through flow chamber)	200 ml/min	100 ml/min	50 ml/min	150 ml/min

8 Part Lists

8.1 Instrument Configurations

Table 8-1: Instrument Configurations

H_2 Instrument	N_2 Instrument	Description
3654/210		Portable battery powered, RS232 (serial) output, For use with sensor 31270.
3654/211		Portable battery powered, RS232 (serial) output, For use with sensor 31272, Special sensor purge: Carbon dioxide.
	3654/510	Portable battery powered, RS232 (serial) output, For use with sensor 31570, Membrane: 29561A.

8.2 TC Sensor and Parts on Configured System

Table 8-2: Sensor and Parts on Configured System

Configured System	Gas	Sensor	Membrane	Holding Ring	Protection Cap	Maint. Kit
3654 Portable Analyzer	N_2	31 570	1 x 29561A	29228	29142	32746
	H_2: 0 to 1 bar	31 270	1 x 29561A			32746
	H_2: 0 to 1 bar		1 x 2952A			32747
	H_2: 0 to 1 bar		1 x 2935A			32748

8.3 Analyzer Spare Parts

Table 8-3: Analyzer Spare Parts

Part N°	Description
28083	Connector LEMO 6, male.
31270	TC Sensor, Substance measured: Hydrogen, Purge gas: Nitrogen, Protection cap provided, Maximum pressure: 10 bar, External Temperature Sensor Included.
31272	TC Sensor, Substance measured: Hydrogen, Purge gas: Carbon dioxide, Protection cap provided, Maximum pressure: 10 bar, External Temperature Sensor Included.
31570	TC Sensor, Substance measured: Nitrogen, Purge gas: Carbon dioxide, Protection cap provided, Maximum pressure: 10 bar, External Temperature Sensor Included.

Table 8-3: Analyzer Spare Parts

Part N°	Description
32013A	Flow chamber in PEEK, with spiral flow path for reduced flow demand for use with TC sensors. Supplied with needle flow valve, outlet metal U-tube (6 mm outside diameter), and 1 meter of inlet tubing.
32015.021/021	Flow chamber in PEEK with Swagelock fittings, for use with H_2 radiation resistant applications. With spiral flow path for reduced flow demand. Supplied with EPDM O-rings. No tubing supplied. Suitable for use up to 10 bar.
32051	Adapter for attaching 32007F flow cell inlet tubing to customer's sample tube. Includes one 6mm (32813) and one 8mm (32814) rubber sealing gasket.
32311	Flow meter equipped with metal exit tube. Graduation from 10 to 100%
32537.03	3 meter RS232 cable for use with portable instruments. Supplied with LEMO 6 connector instrument end and 9D connector computer end.
32688	WIN3654 Windows software and communications cable.
32751	Battery recharger with pack of two rechargeable NiCd batteries (Europe only).
32824A	Fill adapter kit for purge gas cylinder.
32939	Off-mode external power supply.

8.4 Sensor Spare Parts

The Orbisphere Recharge Kit should contain sufficient material for several years of sensor servicing. However, it must be replenished over time.

Table 8-4: Spare Parts Table

Part N°	Description
28114	Membrane support mounting tool.
28129	PPS sensor storage and calibration cap.
28614	Membrane holding ring removal tool, for 31XXX series sensors.
29142	Protection cap with O-ring seal for TC Sensors 31270, 31470, 31478 & 31570.
29228	Stainless steel membrane holding ring with extraction groove.
2935A	Halar membranes, 25 µm, box of 25.
2952A	Tefzel membranes, (32 mm diameter), 25 µm. Box of 25.
29561A	PFA membranes, (32 mm diameter), 25 µm. Box of 25.
32746	Maintenance Kit for carbon dioxide, nitrogen, & hydrogen thermal conductivity sensors with protection cap 29142 for use with the 3654. Includes membranes 29561A, membrane holding ring 29228.01, O-rings 29039.0 and 28613.0, and tools for sensor maintenance.
32747	Maintenance Kit for hydrogen thermal conductivity sensors with protection cap 29142 for use with the 3654. Includes membranes 2952A, membrane holding ring 29228.01, O-rings 29039.0 and 28613.0, and tools for sensor maintenance.
32748	Maintenance Kit for hydrogen thermal conductivity sensors with protection cap 29142 for use with the 3654. Includes membranes 2935A, membrane holding ring 29228.01, O-rings 29039.0 and 28613.0, and tools for sensor maintenance.
32920	Membrane mounting tool including centering guide and plunger.

Appendix A: Glossary

A.1 Common Units

Table A-1: Common Units

Unit	Meaning
%	percentage, by weight
% vbar	percentage per volume, barometric pressure referenced
% vext	percentage per volume, sample pressure compensated
cc/kg	cubic centimeters per kilogram
g/kg	grams per kilogram
mg/L	milligrams per liter
ml/L	milliliters per liter
ppb	parts per billion, by weight
ppm	parts per million, by weight
V/V	volume per volume (ratio)

A.2 Terms and Definitions

Table A-2: Terms and Definitions

Terms	Meaning
Absolute pressure	Absolute pressure is relative pressure, plus atmospheric pressure
Concentration	The relative content of a component in a gaseous or liquid media.
Conductivity	The reciprocal of electrical resistivity.
Headspace	The empty volume above a liquid or solid in a closed container.
Relative pressure	Relative pressure is absolute pressure, less atmospheric pressure (this is the customary gauge reading).
Resistivity	The opposition offered by a body or substance to the passage through it of a steady electric current.

Annex

Tables and Illustrations

User Notes

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